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The Use of Speech-Generating Devices for Preschoolers with Autism Spectrum Disorder

Jessica Miller
University of Arkansas, Fayetteville

The Use of Speech-Generating Devices for Preschoolers with Autism Spectrum Disorder

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by

Jessica Miller
University of Arkansas at Little Rock
Bachelor of Arts in Psychology, 2009
University of Arkansas
Master of Education, 2017

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University of Arkansas

This dissertation is approved for recommendation to the Graduate Council.

_____
Elizabeth R. Lorah, PhD
Dissertation Chair

_____
Christine Holyfield, PhD
Committee Member

_____
Peggy Schaefer Whitby, PhD
Committee Member

Abstract

The first of the following articles provides a review of the literature related to vocalizations among individuals with autism spectrum disorder (ASD) who use augmentative and alternative communication (AAC) systems, with special attention paid to speech-generating devices (SGD). After providing an overview of ASD, evidence-based practices (EBP), and AAC types and a brief history, this review evaluates studies that collected data on vocalizations in SGD-users, including both those that targeted vocalizations as a dependent variable and those that measured vocalizations as a collateral effect without directly targeting it. The goal of this review is to evaluate whether SGD use may lead to an increase in vocalizations and, if so, what interventions have shown promise in this pursuit.

The second article is manuscript of a study evaluating the effects of a multi-phase AAC intervention package using modeling, prompting, and reinforcement on prelinguistic and linguistic partner-directed play communicative behaviors, in three preschoolers with ASD, using SGD. Using a multiple probe across behaviors design nested within a multiple probe across participants design, the researchers modeled and prompted holding up a toy (prelinguistic play communication), activating the SGD button "Look" (linguistic play communication), and engaging in partner-directed gaze with the interventionist. All three participants demonstrated some increase in prelinguistic communication and partner-directed gaze, although only one met and maintained full mastery criteria for all target behaviors. Results are discussed in terms of their contribution to AAC research involving prelinguistic and linguistic communication, and in terms of participant differences, such as prior SGD experience, size of imitation repertoire, and response to social praise, that may help account for variance in acquisition. Future directions are

also discussed, including the need for further research on incorporating prelinguistic targets into SGD intervention.

The final article is directed toward practitioners working with young children with ASD who use SGD and provides research-based guidelines for increasing opportunities for both prelinguistic and linguistic communication in that population. Using the literature reviewed in the first article, as well as the research reviewed and conducted related to the second article, this final article provides research-based strategies for increasing a variety of communicative behaviors, including prelinguistic (i.e., joint attention, gestures, and eye contact) and linguistic (i.e., SGD use as well as vocalizations alongside SGD use), in SGD-users with ASD.

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I would like to thank my mother, who never pressured me to move home to work on my PhD, though it meant I would be closer to her. In the last two months, when I relocated to her house to be quarantined together due to coronavirus, she cooked the majority of my meals so I could focus on my dissertation despite all the changes.

I am thankful for my family members and friends who provided a listening ear and cheerleading when needed. Especially my friend Sara, who was a constant collaborator on all things graduate school and who honed 'extreme time management' alongside me as we went on our graduate journeys on a similar timeline.

My students – both the masters students I taught in my practicum and my preschoolers in the clinic – were part of a learning experience I will remember fondly all my life, and I am thankful for the experience to collaborate with and teach them.

I would like to thank my dissertation committee as well. A special thank you to my advisor, Dr. Elizabeth Lorah, who provided the right balance of oversight and letting me figure out some things on my own. Liz, your ability to speak ABA as if it's a native language has inspired me, and your passion for increasing communication for those who use SGD has become one of mine as well. Dr. Christine Holyfield, thank you for helping me gain a well-rounded perspective, by giving me a glimpse into AAC from the perspective of the speech-language pathology field. Dr. Peggy Schaeffer Whitby, thank you for your guidance as well, during some of the most fun and challenging years of my life.

Finally, while not a 'thank you,' I feel the need to acknowledge the impact that a global pandemic had on my dissertation experience. I was within a couple of weeks of beginning research on my original topic when the university shut down all in-person activity due to the

coronavirus outbreak. Fortunately, the university had an alternative process that consisted of combining three related manuscripts into a dissertation. Though it wasn't what I'd originally intended, I – along with millions of others whose lives were abruptly changed due to COVID-19 – determined to make the best of it and embrace the new normal. I became quite invested in the opportunity the unexpected twist provided – the chance to consolidate several areas of overlapping interests into a collection of manuscripts that I believe will add value to the SGD community – and I am excited about having a tangible answer to the question that will undoubtedly be asked by future generations, "What did you do during the 2020 quarantine?"

Dedication

For my mother. Though I'm now moving away again, these bonus years back home have been precious. Also, thank you for passing along your love of grammar, which has served me well.

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Chapter 1

Introduction

This research seeks to consolidate and expand on the body of literature related to the use of augmentative and alternative communication (AAC) systems, specifically speech-generating devices (SGD), by young children with autism spectrum disorder (ASD). Three manuscripts are presented related to the use of SGD as an AAC, each with a different emphasis but all offered in the hopes of adding to the available research related to teaching strategies for young children with ASD who use SGD.

ASD is a developmental disability with symptoms including deficits in social communication, and the presence of restricted and repetitive behavior patterns or interests (American Psychiatric Association [APA], 2013). It has been estimated that as many as 30% of individuals with ASD do not develop functional speech (Wodka et al., 2013). Many of these individuals are candidates for augmentative and alternative (AAC) communication systems (Ganz et al., 2012), which allow for communication in ways that do not require speech. AAC systems include picture-based systems such as the Picture Exchange Communication System (PECS; Frost & Bondy, 2002), other picture exchange (PE) systems, gestures, manual sign language (MS), and speech-generating devices (SGD; Steinbrenner et al., 2020). SGD are computerized systems that allow a user to select pictures or type words, which are then read by the device in a digitized or synthetic voice (Steinbrenner et al., 2020). The following manuscripts focus primarily on research and interventions related to the use of SGD. However, research conducted in relation to other AAC systems – most frequently PECS, but sometimes MS – has laid the foundation that currently informs the basis of SGD use. For this reason, other AAC systems are discussed briefly when they are relevant to the topic.

Chapter Overview

Each of the following manuscripts has a different emphasis within the topic of AAC/SGD and ASD. The first manuscript (Chapter 2) is a literature review of strategies used to increase vocal output in those who use SGD. An overview of ASD and evidence-based practices (EBP), including applied behavior analysis (ABA), is provided as background. Then the review discusses the current emphasis of interventions involving communication with SGD, which consists mostly of studies involving building requesting skills. Next, the review focuses in on articles related to targeted increases in vocalizations in AAC-users, including studies related to PECS, PE, and MS. The review then explores recent research related to increasing vocalizations specifically in SGD-users, which is a current are of need in the AAC research. Finally, suggestions for future research are provided to address gaps in the literature.

The second manuscript (Chapter 3) presents a single subject experimental design study that examined the effects of prompting, modeling, and reinforcement on the acquisition of prelinguistic (i.e., holding up a toy and making eye contact) and linguistic behavior (i.e., activating the "Look" icon) in three preschoolers with ASD who use SGD. This study used a multiple baseline across behaviors design, nested within a multiple baseline across participants design, in order to evaluate whether many of the techniques reviewed in the literature covered in Chapter 2 would be effective at increasing the use of two prelinguistic behaviors and one linguistic behavior using SGD. Results of the study reveal strategies that may be effective for increasing these behaviors in some individuals with ASD and are discussed in terms of what existing behavioral repertoires may be relevant when choosing prelinguistic and linguistic targets. Results also reveal areas that need continued research, specifically in the arena of teaching prelinguistic behaviors alongside SGD use.

Finally, the third manuscript (Chapter 4) is directed to practitioners working with young children with ASD who use SGD and focuses on consolidating available research into practical guidelines that may be effective in increasing prelinguistic and linguistic communicative behaviors. This article offers specific guidance on choosing both prelinguistic and linguistic targets, pulled directly from the research into EBP for individuals with ASD, along with practical suggestions of how practitioners may expand on this research to teach skills relevant to the individuals with whom they are working.

Significance of the Study

The incidence of ASD is currently estimated to be one in 59 children in the United States (Centers for Disease Control [CDC], 2019). Social communication deficits are central to a diagnosis of ASD, which makes interventions targeted at mitigating those deficits vital (APA, 2013). The following manuscripts are all focused on techniques that have been proven effective for building skills in social communication in individuals with ASD.

The first manuscript (Chapter 2) provides an overview of AAC and SGD research, which may be helpful for those unfamiliar with this growing area. However, the ultimate purpose of the manuscript is to highlight the need for continued research into strategies for increasing vocalizations alongside SGD use in this population. Though not all individuals who use SGD will accompany it with vocalizations, effective interventions must be discovered for those who are able. By summarizing the available research and pinpointing gaps in the literature, it is hoped that future researchers will target interventions aimed at filling these gaps.

The second manuscript (Chapter 3) offers a preliminary investigation of prompting and reinforcement strategies that may be effective for increasing both prelinguistic and linguistic communication in some preschoolers with ASD who use SGD, in a play-based routine. Many of

these techniques, such as the use of a constant time delay, physical or model prompting, and reinforcement with tangible items and/or social praise, are already well-established in research related to ASD treatment (Steinbrenner et al., 2020). However, there is little available research on their use for teaching prelinguistic skills such as gesturing or engaging in eye contact. This manuscript seeks to contribute to and expand on that research, by utilizing these techniques in the context of a play-based activity (i.e., playing with preferred toys in a naturalistic setting). Because play skills are directly affected by deficits in social communication, young children with ASD may need systematic instruction in this area (Chang et al., 2018). The study presented in the second manuscript had variable results, with one participant mastering and maintaining all prelinguistic and linguistic targets (i.e., holding up a toy, activating the SGD, and engaging in partner-directed gaze); and the other two showing an increase in all behaviors, but without mastering any phase. Therefore, more research is needed to further investigate whether these methods will be effective for a variety of individuals with ASD who use SGD.

Finally, the third manuscript (Chapter 4) seeks to contribute to the tools available to practitioners who work with individuals with ASD who use SGD, who may not practice in research-based settings. There is a great need for practical guidance in systematic interventions for teaching SGD use (Ganz, 2015; Lorah, Tincani, & Parnell, 2018). The goal of this manuscript is to summarize available research and to consolidate that research into an easy-to-read and practical guide of strategies for increasing both prelinguistic and linguistic skills in this population. Though these guidelines and strategies are aimed at those in the field of behavior analysis, they should be relevant to anyone who works with children with ASD.

The following manuscripts all seek to either consolidate or add to the available research on increasing skills in the area of social communication, in individuals with ASD who use SGD.

They are presented with the hopes of helping both researchers and practitioners evaluate strategies for increasing both prelinguistic and linguistic communication, in order to make meaningful improvements in the lives of those with ASD who use SGD to communicate.

Target Journals for Submission

Both the first and second manuscripts will be submitted to the *Journal of Physical and Developmental Disabilities*. The primary reason for this selection for both of these manuscripts is because of the interdisciplinary nature of the journal. The first manuscript explores evidence-based practices that may be utilized by any practitioner working with individuals with ASD, and it is hoped that the article will reach those outside the field of ABA, including teachers, special educators, and speech-language pathologists. The second manuscript was co-written by a doctoral level speech-language pathologist as well as a doctoral level BCBA, and pulls from research and strategies used in both of those fields. Therefore an interdisciplinary journal is also appropriate for that manuscript.

The third manuscript will be submitted to *Behavior Analysis in Practice*. Its target audience is practitioners in behavior analysis, although it would also be relevant to other professionals who work with individuals with ASD. This journal was selected because it has several sections in every issue targeted directly toward practitioners, including a technical/tutorial section. This article would be most appropriate as a technical guide, since it is aimed at providing practitioners guidance for choosing targets and teaching procedures, and includes several visual aids for this purpose.

Chapter Two

A Review of the Literature on Increasing Vocalizations in Individuals with ASD Who Use AAC

Abstract

This manuscript provides a review of literature related to increasing vocalizations among individuals with autism spectrum disorder (ASD) who use augmentative and alternative communication (AAC) systems, with special attention paid to speech-generating devices (SGD). After providing an overview of AAC, ASD, evidence-based practices (EBP), and applied behavior analysis (ABA), this review evaluates studies that targeted vocalizations as a dependent variable for those who communicate using AAC, including SGD. The goal of this review is to evaluate whether SGD use may lead to an increase in vocalizations and, if so, what interventions have shown promise in this pursuit.

Keywords: augmentative and alternative communication; autism spectrum disorder; speech-generating device; vocalizations

Introduction

As diagnoses of Autism Spectrum Disorder (ASD) increase, research into effective interventions increases as well. It is vital for those involved in ASD treatment to stay up-to-date on the latest trends and findings in the available research. The following literature provides an overview of ASD, a brief introduction to evidence-based practices (EBP) and applied behavior analysis (ABA), and then examines studies investigating techniques for increasing vocalizations in those who use augmentative and alternative communication (AAC) systems, including speech-generating devices (SGD). Finally, this literature review explores gaps in the research related to increasing vocalizations and offers suggestions for future research in this area.

Review of Background Literature

Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a developmental disability that is estimated to affect one in 59 children (Centers for Disease Control [CDC], 2019). Its hallmark symptoms include deficits in social communication, and restricted and repetitive behavior patterns or interests (American Psychiatric Association [APA], 2013). ASD diagnoses can be categorized as Level One, Two, or Three, depending on the amount of support required by the individual (APA, 2013).

A Level One categorization indicates that an individual requires some support. Someone with a Level One diagnosis will have deficits in social communication and exhibit some degree of inflexible behavior. Difficulty with social communication may include problems initiating interaction and sustaining conversation. Additionally, a person with a Level One diagnosis may show a lack of interest in social interactions and may be unsuccessful at making friends. Individuals functioning at Level One may exhibit difficulty transitioning between activities and

may have problems with organization. These issues may impact the amount of independence the individual attains, but in general individuals with a Level One diagnosis will need the least amount of support (APA, 2013).

A Level Two categorization indicates that an individual will require substantial support. Individuals in this category may have limited vocal communication, often speaking in simple sentences. Nonverbal communication may be unconventional or appear odd to others. Social impairments will be more significant than those experienced by someone with a Level One diagnosis and may include a very narrow range of interests or communication topics, limited initiation of conversation, and abnormal responses to others' attempts at communication. Individuals functioning at this level may exhibit inflexibility of behavior that is more noticeable and interfering than those with a Level One diagnosis. This inflexibility may include distress when transitioning between activities or locations, or perseveration on repeating actions (APA, 2013).

A Level Three categorization indicates that an individual will require very substantial support. These individuals will exhibit severe deficits in both verbal and nonverbal social communication, including limited or no initiation of interaction, and a lack of response to initiations from others. Additionally, individuals at this level may not speak or may have limited speech. Those functioning at Level Three may find changes to routine extremely challenging, and may exhibit distress switching between activities (APA, 2013).

Evidence-Based Practices

Many interventions have been developed for or applied to individuals with ASD, in order to help alleviate symptoms associated with an ASD diagnosis (Masi et al., 2017). Possible treatments include pharmaceuticals, occupational therapy, speech-language pathologist

intervention, and behavioral intervention. When parents and professionals consider which treatments to consider for ASD, it is important that they rely on interventions with empirical evidence for their effectiveness. To this end, evidence-based practices for the treatment of ASD have been outlined. Evidence-based practices (EBPs) are those whose effectiveness has been well-established in scholarly research (Steinbrenner et al., 2020). The process of establishing EBPs is initiated by a review committee who searches databases for studies whose practices are to be evaluated and screening their design methodology and outcomes. Appropriate methodologies include group or single subject experimental or quasi-experimental designs (Steinbrenner et al., 2020). After the selection of studies to be reviewed, a team of reviewers is established. Reviewers are required to have relevant experience (i.e., in this case, experience with ASD and understanding of research methodology), and must complete a training and assessment to ensure they are capable of providing quality reviews. In order to be included as an EBP, a practice must have been supported by at least two unaffiliated experimental or quasi-experimental design studies deemed to be of high quality; at least five single case design studies of high quality and conducted by at least three different researchers/research groups and involving at least 20 participants in total; or a combination of the above categories (Steinbrenner et al., 2020). Most EBPs for ASD intervention are based on the science of applied behavior analysis (ABA; Steinbrenner et al., 2020).

Applied Behavior Analysis

Intervention using the principles of ABA is considered the gold standard for ASD treatment (Masi et al., 2017; Steinbrenner et al., 2020). ABA is the application of the science of behavior to practical problems (Cooper et al., 2020). ABA-based interventions involve analyzing the antecedents and consequences of behaviors and utilizing behavioral strategies to

either increase or decrease behaviors. Everything an organism says or does is considered behavior; ABA addresses both increasing needed skills and decreasing problematic behavior (Cooper et al., 2020).

ABA intervention for ASD. Interventions based on ABA have widespread support in the literature (Peters-Scheffer et al., 2011). Research has shown that behavioral intervention is associated with increases in IQ, appropriate behavior, and sometimes results in individuals no longer meeting the criteria for a diagnosis of ASD (Dawson et al., 2010). Behavioral intervention has also been associated with normalized brain activity patterns, including greater cortical activation when looking at faces, as shown by electroencephalogram (EEG) testing (Dawson et al., 2012).

ABA intervention for ASD focuses primarily on the use of positive reinforcement to increase a variety of desired skills and teach appropriate behavior, while placing inappropriate behavior on extinction. ABA intervention uses strategies such as prompting, prompt-fading, shaping, reinforcement, and extinction to teach a range of variety of skills, including school readiness and academic skills (Fleury et al., 2014; King et al., 2016); social skills (Leaf et al., 2017); and daily living skills such as hand-washing and dressing (Bal et al., 2015). In addition, ABA intervention has been shown to decrease challenging behaviors such as aggression (Matson & Jang, 2014) and self-injury (Morano et al., 2017).

Verbal behavior. Skinner provided a thorough analysis of verbal behavior, which he described as behavior that is "reinforced through the mediation of other persons (Skinner, 1957, p. 2). Skinner (1957) classified aspects of language by the effect each has on the environment. His focus was on function over form. Formal aspects of language include phonemes, morphemes, parts of speech, grammar, and sentence structure. Skinner (1957) did not reject

those designated formal aspects of language but was more concerned with the function of words or phrases. For instance, the word "cookie" may be said for a variety of reasons. A child might ask for a cookie because he/she wants one, because he/she sees or smells one, or because someone has asked the question, "What is something you like to eat?" These utterances of "cookie" would all be formally or topographically the same but would serve very different functions. Additionally, an individual who uses sign language or SGD to communicate "cookie" would be using a different topographical form of verbal behavior, but would be using it according to the same functions as someone speaking the word (Skinner, 1957).

Just as nonverbal behavior can be discussed and analyzed in terms of antecedents and consequences, so too can verbal behavior. Skinner referred to the units of analysis in verbal behavior as *verbal operants*. These operants are frequently targeted for instruction in ABA programs for individuals with ASD (Sundberg & Michael, 2001).

The *mand* is a verbal operant in which the speaker requests or demands something of a listener, and the request is fulfilled (Skinner, 1957). (In this sense, the words *speaker* and *listener* do not imply only spoken words; the speaker and/or listener can use spoken words, signs, text, pictures, or any other mechanism of communicating a message.) For instance, saying, signing, or communicating the concept "I want a cookie," is considered a mand, if the request is fulfilled. The S^D for a mand is the motivation for the item or activity, and the consequence is the delivery of what was manded for. The mand is under control of a state of deprivation or the presence of an aversive stimulus, which is called a motivating operation (MO; Michael, 1982). In the example above, there is an MO for a cookie. Unlike other types of verbal behavior, for which reinforcement can be unrelated to the operant (e.g., tacting a picture of a car can potentially be reinforced by offering a preferred toy that is not a car), by definition a mand

must be reinforced by the item/activity for which an MO is present; otherwise it is not a mand. This MO is an ingredient in what is styled the *four-term contingency*. As previously discussed, the three-term contingency refers to a sequence of an antecedent, a behavior, and its consequences. The addition of motivation as a fourth term, which must be present as part of the antecedent for manding, has been proposed (Michael, 2004). If motivation, in the form of deprivation, satiation, or aversive stimulation, does not exist, an individual will not engage in manding behavior.

The *tact* is the verbal operant described when someone labels something contacted through the senses (Skinner, 1957). For instance, saying, signing, or communicating the word "airplane" because one sees, hears, or touches an airplane; or communicating the word "salty" after smelling the air by the ocean or tasting popcorn. The S^D for the tact is the presence of an object or event, and the consequence is non-specific reinforcement, such as praise or the listener acknowledging the presence of the item being tacted.

The *intraverbal* is a type of verbal operant involving one speaker responding to another speaker's verbal behavior (Skinner, 1957). Intraverbals can be as simple as filling in the blank when asked, "A cow says _____," or as complex as having a conversation about religion or politics. The S^D for the intraverbal is a verbal stimulus, such as a question being asked. The consequence for the intraverbal is non-specific reinforcement, such as praise or another verbal stimulus being provided.

The *autoclitic* is a verbal operant that strengthens or modifies other verbal behavior (Skinner, 1957). For example, adding "I think" at the end of the sentence, "There are 50 states in the United States of America." The phrase "I think," in this example, modifies the certainty of

the speaker. Another example is the inclusion of the word "really" in the following sentence: "I really want to go to the movies."

The *echoic* is the verbal operant involved when a listener repeats the exact sounds or words said by the speaker. The S^D for the echoic is a verbal stimulus, and the consequence is non-specific reinforcement such as praise (Skinner, 1957).

The *textual* is the verbal operant involved when an individual sees a written word and says it aloud. The S^D is the presence of the written stimulus, and the consequence is non-specific reinforcement (Skinner, 1957).

Transcription is the verbal operant at work when an individual says a word, and another individual writes the word down. The S^D is the presence of the spoken stimulus, and the consequence is non-specific reinforcement (Skinner, 1957).

The role of the listener is an important concept in the discussion of verbal behavior. The listener's role is to mediate the consequences of the speaker's behavior (Skinner, 1957). This mediation will look different for different verbal operants. For the mand, the listener provides specific reinforcement, such as giving a cookie when the speaker asks for one. As previously-mentioned, if a request is not reinforced, then it cannot be considered a mand. Mands usually specify their own reinforcement (i.e., the name of the wanted item/activity is stated), and often specify the behavior of the listener (i.e., instruct the listener what to do, such as "Look!" or "Give me the cookie!"). For the tact, the listener's role is to provide generalized non-specific reinforcement, such as acknowledging what the speaker said by saying, "Yes, that is a cat," when a young child points to a cat and says, "cat" (Skinner, 1957). The role of the listener in an intraverbal exchange is to provide non-specific reinforcement, such as offering praise or continuing a conversation. The listener's role in the echoic is also non-specific reinforcement,

often educational reinforcement (Skinner, 1957); such as when a teacher pronounces a word correctly, a student repeats, and the teacher verifies that the word was said correctly.

Skinner (1957) discussed the verbal operants in relation to all human language, but intervention with those with ASD and other developmental disabilities currently comprises one of the most common applications of the teaching of verbal operants (Johnson et al., 2017; Carnett, Raulston, & Charpentier, 2019).

Teaching settings. ABA procedures can be implemented in a variety of settings, including homes, classrooms, the community, or anywhere instruction is needed (Leaf et al., 2018). Two common methods of instruction are discrete trial instruction (DTI), which is also known as discrete trial teaching, (DTI; Lerman et al., 2016) and natural environment teaching (NET; LeBlanc et al., 2006). DTI is a teacher-led procedure with a very specific structure, including an S^D, a prompt if needed, a response by the student, a consequence, and an intertrial interval before the next trial is presented (Lerman et al., 2016). NET is a less-structured teaching procedure, and involves following the child's MO and letting him/her select toys or items to engage with. The teacher or therapist will embed teaching in this naturalistic setting, still using prompting and reinforcement. Manding is often a large focus of NET instruction (LeBlanc et al., 2006).

Augmentative and Alternative Communication

It has been estimated that approximately 50% of individuals with ASD do not achieve fluent speech by age eight, and approximately 30% are considered functionally non-vocal (Wodka et al., 2013). For individuals who do not develop functional or fluent speech, augmentative and alternative communication (AAC) systems provide a means of communication that involves supplementing or replacing speech (Ganz et al., 2012). AAC systems are classified

as either aided or unaided (Mirenda, 2003). Aided systems use some type of equipment or materials, such as pictures, photographs, or written words, which are communicated using a variety of high and low-tech systems; while unaided systems involve using one's own body, such as gestures, manual sign language, body language, or vocalizations that are not fully-developed words (Mirenda, 2003). As technology advances, many AAC systems involve the use of computerized devices, such as applications for the iPad®. These devices function as speech-generating devices (SGD) and involve digitized or synthetic vocal output, which is available in a variety of voices, matching the age, gender, and nationality of the individual (Steinbrenner et al., 2020). ABA-based interventions used with AAC have shown to be effective for increasing social skills, reducing challenging behavior, and increasing communication (Ganz et al., 2012; Hart & Banda, 2010). In the past few years, much research into AAC systems has focused on teaching the acquisition of verbal behavior using ABA-based strategies.

Studies have found that individuals with ASD can be taught to use PE to communicate a range of verbal behavior. Fewer studies have been done on the connection between PE and the acquisition of speech, although some of what has been done shows promise. This research generally follows two paths – examining whether the use of PE is associated with a collateral increase in vocalizations (without being directly targeted), and whether, if specifically targeted, vocalizations can be shaped alongside PE. These same research paths, which are elaborated on below, can be found regarding SGD; though to a lesser extent, since the use of SGD is a newer development. Much of the research into vocalizations targeted alongside AAC use is in the context of manding or mand training.

Mand Training

In typically-developing children, the mand is usually one of the first verbal operants acquired (Cooper et al., 2020). Children with ASD, however, frequently do not develop a functional mand repertoire without direct training, even when they learn to use the same words as tacts or other verbal operants (Hall & Sundberg, 1987). For instance, a child may say the word "cookie" when he/she sees a cookie, or may be able to answer when asked what Cookie Monster eats, but may not use the word "cookie" when he/she wants one. A mand repertoire must often be specifically and strategically taught to individuals with ASD.

Because the mand is the only verbal operant that directly benefits the speaker, it is frequently targeted early in ABA programs (Sundberg & Michael, 2001). The development of a mand repertoire provides an individual with the ability to contact reinforcement more readily, because he/she will be able to ask for wanted items/activities, rather than relying on others to guess what his/her needs and wants may be. Theoretically, it has been suggested that because those with a manding repertoire experience this direct benefit of using language, there may also be an increase in their finding value in language in general (Sundberg & Michael, 2001).

Mand training involves capturing or contriving the MO (Michael, 2004), and providing opportunities for the individual to request the item or activity he/she wants. This must be conducted when an MO is in place or when one can be contrived. The most basic example of mand training is withholding access to an item that an individual has indicated motivation for, until he/she says the name of the item either independently or with prompts. Varieties of this procedure can include teaching individuals to mand for missing items (Endicott & Higbee, 2007; Albert et al., 2012) and for information (Shillingsburg & Valentino, 2011).

Effects on problem behavior. There is evidence to suggest that mand training can lead to a decrease in problem behavior (Habarad, 2015). This is proposed to be because manding can replace other methods of acquiring needed or wanted items/activities, such as screaming or hitting. Functional communication training (FCT) is a procedure often used in the treatment of severe problem behavior, that involves teaching appropriate mands (i.e., asking for help) to replace inappropriate behaviors that served the same function (i.e., screaming or hitting), and making sure those inappropriate behaviors no longer result in the individual acquiring reinforcement (i.e., extinction) (Tiger, Hanley, & Bruzek, 2008). FCT is considered an EBP for ASD (Steinbrenner et al., 2020), and has been associated with decreases in challenging behavior including disruptive behavior, aggression, and self-injury (Gerow et al., 2018).

Mand training with SGD. Within the research on mand training using SGD, studies have evaluated various procedures for teaching many types of mands – including mands for actions, for information, multi-step mands, and mands to peers. Carnett, Bravo, & Waddington (2019) used a multiple probe design to evaluate the use of an *interrupted chain procedure* for teaching three children with ASD to mand for actions. An interrupted chain procedure involves interrupting a behavior chain by withholding a needed item, thereby contriving an MO, or state of deprivation (Shafer, 1994). In this study, the procedure involved the interruption of a preferred activity (e.g., playing a video game or watching a video), using a constant time delay followed by least-to-most prompting, to teach participants to request the continuation of the activity. All three participants met mastery criteria, and two maintained their progress at follow-up. However, two participants required procedural adaptations that involved conducting five errorless trials prior to each session. These were faded after three independent mands, and both participants then mastered the original criteria. Some of the limitations of this study included the

procedural modifications necessary for two out of three participants to reach mastery criteria, and the fact that one participant did not maintain progress at follow-up. This participant was re-trained to mastery, but time constraints meant there was not a chance to assess maintenance again, so it is unknown if her progress would have maintained after re-training. Carnett et al. (2019) did not evaluate whether vocalizations increased for any of the participants during the intervention.

Shillingsburg et al. (2019) used a nonconcurrent multiple baseline design to evaluate the effects of a constant time delay on the acquisition of mands for information, in three 3-7-year-old participants with ASD who used SGD. Textual and gestural prompts were effective for teaching the mands "Which?" and "Who?" to all three participants. This study extended the SGD literature by showing that users can be taught to engage in complex communication using SGD. Shillingsburg et al. (2019) did not assess generalization of the learned SGD responses, to see if they would occur in other settings or in the absence of the participants' SGDs.

Alzrayer et al. (2017) used a multiple probe design to evaluate a procedure using least-to-most prompting, constant time delay prompts, and differential reinforcement to teach multi-step mands to four participants with autism or developmental disabilities, using the Proloquo2Go™ application on the iPad. All participants acquired the skills of navigating pages on the device and combining symbols to mand for preferred items and activities. These skills generalized across new items and activities for three out of four participants. Interestingly, for two participants, the speech output feature had to be disabled before functional control was seen. This was hypothesized to be necessary in order to reduce distractions and the ability of the participants to engage in repetitive behavior. This result has not been reported in other reviewed

studies. However, this was a limitation of the intervention, and should be considered in future research.

Lorah, et al. (2019) examined the use of an interrupted chain procedure (Shafer, 1994) for increasing manding to neurotypical peers in three preschool-aged children with ASD, using a multiple baseline design. In this study, peers were instructed to withhold an item needed for a task-related activity, such as a puzzle piece. Using a five-second constant time delay and full physical prompts, participants were taught to mand for the missing item from the peer, using Proloquo2Go. All three participants acquired and maintained the skill. One limitation of this study was that time constraints only allowed for one maintenance session for one participant and two for another, so it is unknown whether the results would have maintained over a longer period of time. This study supports the use of constant time delay prompts and full physical prompts for SGD activation.

Method

This review covered peer-reviewed studies that evaluated procedures for increasing vocalizations in those who use AAC. Though SGD studies were of primary relevance, studies that targeted vocalizations as a dependent variable in those who used any type of AAC were included.

Inclusion Criteria

In order to be included in this review, a study must have had increasing vocalizations alongside AAC as a dependent variable. Studies that measured vocalizations but did not directly target them for increase were not included. Additionally, SGD studies using technology older than 2008 were excluded so as to be consistent with devices currently available; non-SGD studies were included regardless of the year published.

Search Strategy

The search for articles was conducted in January 2020. Google Scholar and ERIC online databases were searched using the following terms with Boolean operators and truncation: autism spectrum disorder, speech generating device, increasing vocalizations, augmentative and alternative communication. Abstracts of articles with relevant titles were screened to determine if they met inclusion criteria.

Results

As seen in Table 1 (See Appendix A), three studies were found that directly targeted increases in vocalizations with non-SGD AAC systems. These studies are Carbone et al. (2010), which focused on manual sign; and Tincani (2004), and Tincani et al. (2006), which both focused on PECS (Frost & Bondy, 2002). Another three studies (See Appendix A) were found that targeted increases in vocalizations using SGD. These studies were Gevarter et al. (2016), Gevarter and Horan (2019), and Bishop et al. (2020).

Discussion

Non-SGD AAC Studies Targeting Vocalizations

Three studies were found that directly targeted vocalizations as a dependent variable during ABA intervention using AAC systems. Carbone et al. (2010) used a multiple baseline design to evaluate the effects of prompt delay and vocal prompting on the acquisition of vocalizations in three children with developmental disabilities who used manual signs to communicate. The procedure consisted of delaying access to items that participants signed for, unless the sign was accompanied by a vocalization. If no vocalization occurred within five seconds of signing, the implementer said the name of the item up to three times. If the

participant vocalized at any point, he/she was immediately given access to the item. If he/she did not vocalize at all, access was granted at the end of the trial. All three participants showed an increase in vocalizations during intervention. One participant required prompting for many vocalizations at the beginning of the intervention, but by the end was making unprompted vocalizations at a rate three times higher than baseline. One limitation of this study was that vocalizations outside intervention were not assessed.

Tincani (2004) conducted PECS and sign training with two individuals with ASD, and compared acquisition of mands as well as word vocalizations. One participant acquired a higher percentage of independent mands with PECS and the other with sign. Sign language training led to a higher percentage of vocalizations for both participants. The author notes that speech acquisition in PECS generally occurs in Phase IV, and this study ended with Phase III acquisition, which may have impacted the results. Additionally, researchers implemented a procedural modification to the PECS condition, in which they introduced a time delay before reinforcing the mand. This delay led to an increase in vocalizations that were similar to those in the sign language condition (Tincani, 2004). One limitation of this study was the low number of mand opportunities in each session. The author notes that the average number of opportunities per session was only 22, which is lower than the number of 30-40 suggested by Bondy and Frost (2002) for initial PECS training.

Tincani et al. (2006) reported two studies related to vocalization acquisition in PECS users with ASD. In the first study, one participant acquired up to Phase II of PECS, and one acquired up to Phase IV. For the participant who acquired Phase IV, an increase in speech coincided primarily with Phase IV. The other participant did not acquire speech in this study. In the second study, the researchers sought to establish a functional relationship between Phase IV

of PECS and speech acquisition, in a different participant. An ABAB design was used, in which vocalizations were not reinforced in Condition A and were reinforced in Condition B. The participant's speech increased in Condition B only, with word approximations occurring in fewer than 5% of opportunities in Condition A and more than 80% in Condition B. A major limitation of these two studies is the low number of participants – two participants in the first study and only one in the second. These results should be replicated using more participants, in order to increase their validity. The authors note that an area of future related research would be to evaluate prompting and reinforcement strategies aimed specifically at increasing vocalizations in AAC users.

The preceding studies lend some support to the premise that the use of AAC can lead to an increase in vocalizations for some individuals with ASD. Though the preceding studies did target vocalizations as a dependent variable, most were conducted using AAC systems that did not include speech output, such as PE/PECS and manual sign. The lack of research targeting vocalizations directly in SGD intervention is a major limitation of the literature that future research should address. There are a few studies that have directly targeted vocalizations as a dependent variable.

SGD Studies Targeting Vocalizations

Three studies were found that directly targeted vocalizations during SGD manding in children with ASD. All three studies were similar, with slight variations in methodology. Gevarter et al. (2016) examined the impact of constant time delay, differential reinforcement, and echoic prompts on increasing vocalizations occurring with SGD mands for preferred items, among four children (ages 4-7) with ASD. All participants in this study had prior AAC experience, including manual sign, PECS (Frost & Bondy, 2002), and the SGDs GoTalk Now,

LAMP Words for Life, AutisMate, and Scene and Heard. In the first phase of their study, researchers implemented a five-second constant time delay after independent SGD activation (prompted SGD trials were not subject to the following procedures). If the participant offered the target vocalization, which was individualized for each participant, during the delay, he/she was given immediate access to the preferred item. If he/she did not make the target vocalization, a distractor trial was conducted, after which a less-preferred item was provided for up to 20 seconds. If participants did not meet mastery criteria for Phase One within a given time frame, Phase Two was initiated. In Phase Two, a vocal model was provided after the initial five-second delay. If a participant did not make the target vocalization within five more seconds, a distractor trial was presented and the less-preferred item was given. If a participant did make the target vocalization following the echoic prompt, he/she received the more highly-preferred item immediately. Phase One was reintroduced after mastery of Phase Two. Two out of four participants responded to the procedures in Phase One. For one participant, Phase Two was necessary before mastery of Phase One was achieved. For the remaining participant, Phase Two was effective in evoking echoic responses, but mastery criteria were not met. Phase One was reintroduced with this participant regardless, but independent vocalizations remained similar to his baseline (Gevarter et al., 2016).

This study's primary limitation was that the researchers did not reinforce mand trials in which participants did not vocalize following the time delay or vocal prompts. Instead, participants were given a distractor trial and then provided access to a less-preferred item or activity. Because the definition of a mand requires that the reinforcement be the item/activity asked for, the interventionists in this study were not reinforcing all mands. Rather, when SGD requests were not accompanied by vocalizations, participants were given items that had

previously been manded for but were not manded for during the current trial. Though most participants did respond positively to the intervention, it is possible to implement a variation of this procedure that does not place any mands on extinction, thereby leading to more manding opportunities.

Bishop et al. (2020) replicated and extended Gevarter et al. (2016) by using a more robust research design (i.e., concurrent instead of nonconcurrent multiple baseline), and by adding a multiple stimulus without replacement preference assessment (MSWO; DeLeon & Iwata, 1996) before each session. Participants were three boys (ages 5-10) with ASD, two of whom had no AAC experience, and one of whom used an unspecified SGD. The researchers found an increase in vocalizations for all three participants, although all required the echoic prompting phase as opposed to just the time delay phase. Additionally, all three participants showed an increase in novel vocalizations throughout the course of the study (Bishop et al., 2020). This study had the same primary limitation as the study it replicated (Gevarter et al., 2016).

Gevarter and Horan (2019) used similar procedures to Gevarter et al. (2016), but included data on SGD experience prior to intervention. Participants in this study were six children with ASD, ages 5-10. Three participants in this study had experience using SGD, specifically the GoTalk9, and three had experience with non-electronic picture-based AAC systems. For three out of six participants, the time delay was sufficient to increase vocalizations. Two of the remaining participants increased vocalizations after the addition of the vocal model. For one participant, no increase in vocalizations occurred. For the five participants whose vocalizations increased, generalization probes showed vocalizations maintained without the presence of the SGD. The researchers found that independent SGD usage remained at a stable high throughout the study, suggesting that the response effort of using the SGD and vocalizations was not too

high for the participants. Two of the three participants with no prior SGD experience were among those to meet mastery criteria, while the one who did not meet criteria was new to SGD. Further research is needed to determine whether there are differences in vocalization acquisition between learners with various levels of SGD independence. Gevarter and Horan (2019) also evaluated whether their vocal prompting procedures were effective for learners with low echoic repertoires. They found that all three participants who were categorized as low-scoring on the Early Echoic Skills Assessment (EESA; Esch, 2008) were among those for whom this procedure was effective. However, two of the three did require the vocal model and did not respond to just the time delay phase. This study provides supporting evidence that vocal prompting strategies used in conjunction with SGD mand training can be effective in increasing vocalizations in those with low echoic skills at baseline. Gevarter and Horan (2019) used similar methods to Gevarter et al. (2016), and had the same limitations, including the potential extinction of some mands.

Gaps in the Literature and Future Research

There are relatively few studies examining procedures for increasing vocalizations alongside SGD use, although two (Gevarter & Horan, 2019; Bishop et al., 2020) were published in the last year; therefore it is likely that such studies will increase in the next few years. Future researchers should consider expanding the body of literature on vocalizations as a dependent variable, rather than just being measured as a collateral effect of manding or in mand training. Future research should also explore methods of increasing vocalizations alongside tacts, intraverbals, and other verbal operants.

Another gap in the literature relates to examining strategies to increase vocalizations during manding while still reinforcing all mands. All three of the reviewed studies that had vocalizations as a dependent variable alongside SGD use (Gevarter et al., 2016; Gevarter &

Horan, 2019; Bishop et al., 2020) used a procedure in which mands not accompanied by vocalizations were not reinforced. Rather, the participants were provided another, less-preferred item. This strategy was effective for some participants, but risks putting mands on extinction, especially in participants who have not already developed a fluent SGD manding repertoire. Future researchers could consider using differential reinforcement for mands with vocalizations (i.e., providing reinforcement of greater duration or magnitude, such as longer access to an item), while still reinforcing mands that occur without vocalizations. This was done in the Carbone et al. (2010) study that used manual sign, but was not found in any of the reviewed studies relating to SGD.

Finally, researchers may consider targeting any vocalizations, rather than specific targeted vocalizations, especially at the beginning. Gevarter et al. (2016), Gevarter and Horan (2019), and Bishop et al. (2020) all selected specific target vocalizations (either the first sound of the wanted item or a targeted sound somewhere in the word, that was already in the participants' repertoires). Future research could explore interventions that target any vocalization, or that start with reinforcing any vocalization and then shape closer approximations.

Conclusion

The preceding literature review provided an overview of current trends in the treatment of individuals with ASD who use AAC systems, with an emphasis on SGD. Effective procedures have been established for increasing the verbal behavior repertoires of individuals with ASD who use SGD, but there is still room for much more exploration. Research should continue to focus on increasing the verbal repertoires of individuals with ASD who use SGD, to include a variety of verbal operants; and should also continue to evaluate interventions to increase vocalizations alongside SGD use. With tablet-based devices becoming more readily

available, it is highly likely such research will increase; and will continue to support the use of SGD as an effective method of communication for those with ASD who do not speak vocally.

Chapter Three

Effect of Multi-Step AAC Intervention Package on Three Partner-Directed Communicative Behaviors during Play in Preschoolers with ASD

Jessica Miller, Christine Holyfield, and Elizabeth R. Lorah

Abstract

This study evaluated the effects of a multi-phase augmentative and alternative communication (AAC) intervention package using modeling, prompting, and reinforcement on prelinguistic and linguistic partner-directed play communicative behaviors, in three preschoolers with autism spectrum disorder (ASD), using a speech-generating device (SGD). Using a multiple probe across behaviors design nested within a multiple probe across participants design, the researchers modeled and prompted holding up a toy (prelinguistic play communication), activating the SGD button "Look" (linguistic play communication), and engaging in partner-directed gaze with the interventionist. All three participants demonstrated some increase in prelinguistic communication and partner-directed gaze, although only one met and maintained full mastery criteria for all target behaviors. Results are discussed in terms of their contribution to AAC research involving prelinguistic and linguistic communication, and in terms of participant differences, such as prior SGD experience, size of imitation repertoire, and response to social praise, that may help account for variance in acquisition. Future directions are also discussed, including the need for further research on incorporating prelinguistic targets into SGD intervention.

Key words: augmentative and alternative communication; autism spectrum disorder; prelinguistic communication; gaze behavior; play

Introduction

Play is critical in the life of a preschooler, because it provides opportunities for learning (Samuelsson & Johansson, 2006), language and communication building (Toub et al., 2018), and fostering relationships with peers (Mathieson & Banerjee, 2010). For preschoolers with autism spectrum disorder (ASD) who have limited or no functional speech, participation in play may be limited (Chang et al., 2018). This is problematic, given that much of the learning they may not be experiencing during play, such as developing social communication, is learning that is related to limitations central to the diagnosis (American Psychiatric Association; APA, 2013). Preschoolers with ASD and limited speech may require intervention to promote language learning and social communication growth. Augmentative and alternative communication (AAC) intervention – or access to teaching and technology to promote communication through means other than speech – is one such approach that can benefit preschoolers with ASD (Ganz et al., 2012).

AAC intervention can support children in building a range of communication skills (Romski et al., 2002). This includes both prelinguistic and linguistic communication (Olsson & Granlund, 2003). Prelinguistic skills communicate messages without using symbols (i.e., language), such as laughing, high fiving, reaching for an object, or holding up an object to show it to another person (Ogletree & Pierce, 2010). Linguistic communication uses words as symbols to communicate (e.g., using a communication application on mobile technology as a speech-generating device; SGD). For AAC-users, words could be communicated through a range of modalities including spoken language, manual signing, or selection of the voice output of a word from a high-tech, computer-based device (Mirenda, 2003).

Typically-developing preschoolers use both prelinguistic (e.g., smiling and laughing) and linguistic (e.g., talking with friends) communication during play. However, despite the importance of play for young children (Samuelsson & Johansson, 2006; Toub et al., 2018; & Mathieson & Banerjee, 2010), and the fact that limitations in prelinguistic and linguistic communication can hinder participation in play for children with ASD and limited speech (Chang et al., 2018), there is limited research available evaluating AAC interventions to promote prelinguistic and linguistic communication in preschoolers with ASD during play.

Lerna et al. (2014) assessed 14 children with ASD who had been trained on the Picture Exchange Communication System (PECS; Frost & Bondy, 2002) 12 months prior to their study, in order to test whether effects on socio-communicative skills would be evident in PECS-users versus a control group who had been treated with conventional language therapy. The researchers collected psychometric data and observed participants in unstructured free-play interaction with an adult. Results showed the PECS group had lower Autism Diagnostic Observation Schedule (ADOS; Lord et al., 1999) severity scores in the areas of Communication, Social, and Total. Additionally, observation of free-play found that those in the PECS group showed significantly higher scores over the control group in the areas of joint attention, initiation, duration of cooperative play, and verbal requests. This study provides preliminary evidence that AAC use may facilitate the development of prelinguistic communication, including joint attention, as well as linguistic communication such as verbal requests. Some limitations of this study include the relatively small sample sizes for group designs, and the fact that the participants were not randomized (Lerna et al., 2014).

Thiemann-Bourque et al. (2018) evaluated the effects of a peer mediation intervention with 2-5-year-olds with ASD in a preschool setting, using a multivariate randomized control trial

(RCT) design. This study used several cohorts of children over a four-year period. The treatment group consisted of 23 participants and their typically-developing peers; the comparison group consisted of 22 participants and their typically-developing peers. The treatment and the comparison group both participated in 15-minute sessions two or three times per week for between nine and 19 weeks. Peers in the treatment group were trained to stay with the participant they were paired with, to play and interact with the toys the participant was interested in, and to model the use of the SGD and respond to initiations from the participant. During the intervention, the school staff prompted the participants and typically-developing peers as necessary (i.e., prompted turn-taking or the use of the device). The peers in the comparison group were not given specific instructions. Rather, the staff were instructed to ensure that a peer was present and that the SGD symbols were appropriate to the context. There were also instructed to interact as they usually would with the participant and peer.

The treatment group (both participants with ASD and peers) showed significantly more social communication gains, including more intentional communication, more initiations, as well as a more balanced ratio of initiations to responses. Researchers measured both prelinguistic communication (i.e., gestures and eye contact) and linguistic communication (i.e., vocalizing or activating SGD), though the results to not break these behaviors down to show increases in each separately. The participants' communication skills maintained after the treatment ended and generalized to non-trained peers. The preschool staff involved in this study indicated high levels of satisfaction with the methods and outcomes, on a social validity survey. Staff rated satisfaction on a Likert scale from one to five, with one being the lowest level of satisfaction and five the highest. Some limitations of this study include a relatively low number of children for RCT, and the fact that the children in the comparison group were not observed as frequently as

those in the treatment group. However, the authors note that measurements for the comparison group remained low and stable at every observation, minimizing the need for more observation. This study contributes to the body of evidence suggesting SGD can be effective alongside interventions used to increase social communication during play, in this case between peers. Further, the high satisfaction ratings given by the preschool staff, and the increased communication skill gains made by the neurotypical peers show that SGD-based interventions can be successfully implemented in a classroom environment, with practical benefits for all children in the environment (Thiemann-Bourque et al., 2018).

Lorah, Karnes, Miller, and Welch-Beardsley (2019) evaluated the use of an interrupted chain procedure (Shafer, 1994) for increasing mands directed toward neurotypical peers in three preschool-aged children with ASD, using a multiple baseline across participants design. In this study, which took place in a naturalistic teaching setting in a university-based autism research clinic, peers were instructed to withhold an item needed for a task-related activity, such as a puzzle piece. Using a five-second constant time delay and full physical prompts, participants were taught to mand for the missing item from the peer, using Proloquo2Go. All three participants acquired and maintained the skill. One limitation of this study was that time constraints only allowed for one maintenance session for one participant and two for another, so it is unknown whether the results would have maintained over a longer period of time. This study adds to the research supporting the use of SGD for teaching linguistic communication to preschoolers with ASD within a play-based context and for the use of a constant time delay and full physical prompts, which were also used in the current study (Lorah et al., 2019).

Outside of research in ASD, a recent research study evaluated the efficacy of an AAC intervention in promoting the frequency and complexity of prelinguistic communication (in this

study's case, gaze behaviors) in children who have multiple disabilities (Holyfield, 2019) during preferred play activities. The study found the intervention to be effective, with all participants seeming to benefit from the intervention. The intervention used modeling, prompting, and feedback to promote prelinguistic communication. However, the study did not include any children with ASD. It also was focused on prelinguistic communication alone and did not target increases in linguistic communication.

The preceding studies provide an evidence base for the use of modeling, constant time delay, and physical prompting for increasing linguistic communication in SGD-users with ASD. There is also evidence that the use of AAC systems may support the development of prelinguistic skills such as joint attention (Lerna et al., 2014). However, there is a lack of research exploring the efficacy of AAC intervention on increasing both prelinguistic and linguistic communication during play activities for children with ASD. Therefore, the goal of the current study was to conduct an initial exploration of the effects of a multi-phase intervention package using prompting, modeling, social praise, and high-tech AAC, specifically SGD, on prelinguistic and linguistic partner-directed play communicative behaviors in three preschoolers with ASD. Specifically, the current study seeks to extend the literature by assessing whether the treatment package is effective for increasing the frequency of the use of a gesture, the use of the word "Look" on the SGD, and the use of partner-directed gaze, while showing a toy to a communication partner during play. Further, the current study seeks to determine whether any observed effects maintain after intervention has ended and whether effects generalize to a natural environment setting with peers with ASD.

Method

Participants

Informed consent was obtained from all participants' parents prior to the start of the study, which was approved by the university's institutional review board. Inclusion criteria for participation in this study included having a clinical diagnosis of ASD from an independent agency, being between the ages of two-and-five, and having the ability to select an icon in a field of two on an iPad®-based speech-generating device (SGD). One participant, Shontae, was in his fifth semester at the learning center.

As depicted in Table 2 (See Appendix B), the participants in this study were three preschool-aged children, two boys and one girl, diagnosed with autism spectrum disorder (ASD). All three participants attended a university-based research learning center three days a week, for 2.5 hours each day. The clinic was set up like a preschool and used the methodology of applied behavior analysis (ABA). Two participants, Gazala and Diego, were in their first semester. Shontae's and Diego's family spoke English at home, while Gazala's spoke Tamil. Prior to intervention, each participant was assessed using the *Verbal Behavior-Milestones Assessment and Placement Program Barriers Assessment* (VB-MAPP; Sundberg, 2008). Participants were assessed in the domains of social skills, mand repertoire, and motor imitation, in order to determine if prerequisite skills in those areas would be associated with faster acquisition of the target behaviors. All three participants scored in Level 1 (of 3 total levels, with Level 3 being most advanced) on social skills. Gazala and Diego also scored in Level 1 in manding and motor imitation. Shontae had a Level 2 manding repertoire, and had mastered all motor imitation targets, which are only assessed in Levels 1 and 2 (Sundberg, 2008). Participants were also assessed to determine the field size in which they were able to navigate on the SGD. This was

done for all preschoolers attending the clinic as part of their regular instruction. The procedure involved starting with one available icon, and collecting data on independent and accurate manding throughout the preschool day. When an individual reached 80% accurate and independent responding in a field of one over three days, the field size was increased to two. Each time the 80% criterion was met, the field size was increased. Different folders were used for different areas or activities of the day (e.g., snack time; free play), and these same criteria were used for increasing the field size in each folder. Some children eventually learned to navigate between folders.

Materials and Setting

Materials used in this study included a variety of preferred toys (including action figures/dolls, magnetic blocks, puzzles, and plastic animals) and an iPad® with the Proloquo2Go™ application as a speech-generating device (SGD). As seen in Figure 1 (See Appendix B), each participant's SGD had only two icons visible – one that had the printed text, "Look" and one with the printed text, "Cool!"

The setting for this study was the clinic, which consisted of a large main classroom for natural environment teaching (NET) and two smaller rooms used for discrete trial instruction (DTI). The NET area was where children in the preschool engaged in naturalistic learning, including looking at books, playing with puzzles and games, engaging in sensory activities, and playing with dolls or action figures. Most sessions were conducted in the large room where NET activities took place, which contained two kidney bean-shaped tables and several chairs, as well as various activity centers, including sensory, task completion, books, toys and kitchen, and construction. Three sessions for Gazala were held in the DTI rooms, which contained square tables and two chairs, DTI materials, and a few preferred items used for reinforcement. This was

done because Gazala occasionally arrived late, and missed the NET session in which the study would have been conducted. Because the preschoolers rotated between DTI and NET rooms throughout the morning, it was decided to take her preferred items to the NET room and keep her on her regular rotation.

Dependent Measures

The first dependent variable (DV1), which served as the target in Intervention Phase 1, was holding up a toy following the therapist's model. An independent response in Phase 1 required the child to respond within five seconds, by holding up his/her item using one or both hands, so that the participant's hand was at least at his/her chest height and was oriented toward the speaker. Non-examples included lifting the item just a few inches off the floor and/or holding the item in a direction that the interventionist would have to turn his/her head away from the child's face to see it. In this phase, if no response or an incorrect response occurred within five seconds, full physical prompting was used. Data were collected on holding up the item, activating "Look," making PDG, and activating "Cool!" A correct response for "Cool!" was only marked if the student activated the icon at the appropriate time, after the interventionist held up her item.

The second dependent variable (DV2), which served as the target in Intervention Phase 2, was holding up the toy as well as activating the SGD button "Look" or saying "Look" vocally. A correct response in this phase consisted of the participant holding up the toy as described in Phase 1 and either saying the word "Look" vocally, with clear enough articulation that in the implementer's clinical judgment a non-familiar listener would recognize the word, or pressing the SGD button "Look" with enough force to evoke vocal output. A correct response was recorded if both responses occurred. In this phase, full physical prompting was used in cases of

a non-response or an incorrect response. If prompting was necessary, the response of activating "Look" was prompted first, followed by holding up the item. Data were also collected on PDG and activation of the "Cool!" button, though these steps were not prompted.

The third dependent variable (DV3), which served as the target in Intervention Phase 3, was engaging in partner-directed gaze (PDG). A correct response for PDG required the child to respond within five seconds, by holding up his/her item according to the criteria described above, activating the "Look" button or saying "Look" vocally, and to look in the direction of the implementer's face, with his/her head oriented toward the implementer. Again, the order of these steps did not matter, as long as one was initiated within five seconds, and all were completed with no more than a five-second latency between any two consecutive steps. A correct response was recorded if all responses occurred in any order. In this phase, full physical prompting was used in cases of a non-response or incorrect response for holding up the item and activating "Look." If prompting was necessary for PDG, this was done by the interventionist moving the item around near her own eyes, to attract the attention of the participant. Data were also collected on activation of the "Cool!" button, though this step was not prompted.

For each of the variables, the measure of successful use of each behavior was the number of trials in which the participant demonstrated the behavior divided by the total number of trials in the session (10), then multiplied by 100 to yield a percentage. Only those behaviors demonstrated independently (i.e., prior to prompting) were counted. Mastery criteria were set at 80% independent and accurate responses across three consecutive sessions.

Generalization probes were measured in two ways. First, data were collected on whether each participant independently and accurately performed any of the target behaviors during a ten minute free play probe. Secondly, the graduate students who were implementing the study were

also instructed to write down if a participant performed one of the targeted skills outside of the study, in either natural environment or discrete trial instruction settings.

Experimental Design

The study used three multiple baseline designs across behaviors, nested within a multiple baseline across participants design (Ledford & Gast, 2018) and assessed for maintenance and generalization. The multiple baseline across behaviors design was chosen for each participant because there were three target behaviors of interest, which were independent of each other but functionally similar and were unlikely to reverse. The multiple baseline across behaviors was nested within a multiple baseline across participants design in an attempt to add a higher degree of experimental effect (Ledford & Gast, 2018). The study had five phases: baseline, Intervention Phase 1, Intervention Phase 2, Intervention Phase 3, and maintenance. Maintenance sessions were identical to baseline. Generalization probes were completed in all phases, and consisted of observing all participants in a free play setting with SGDs within three feet, to assess whether they would independently engage in any of the target behaviors with peers or adults in the room.

Experimenters

The interventionists in this study were three master's students pursuing their board certification in behavior analysis, and one doctoral student who was a board certified behavior analyst (BCBA).

Interobserver Agreement and Procedural Fidelity

Interobserver agreement (IOA) data were collected in 47% of sessions, including baseline, training, maintenance, and generalization phases across all participants. IOA sessions were conducted by the primary investigator or occasionally another graduate student. IOA data

were calculated by dividing the number of agreements by the number of agreements and disagreements, and multiplying by 100. The overall agreement was 98.1% (range: 82-100%).

Procedural fidelity checklists are shown in Figure 2 (see Appendix C) were used to ensure procedures were followed correctly. The checklists included self-assessment questions related to the study procedures (i.e., "Did you provide any probes during baseline?"), which each interventionist completed after each session. Overall fidelity was 100%. IOA on procedural fidelity data was 97.9% (range: 75-100%). The primary investigator was present for over 90% of sessions, in order to ensure fidelity of implementation.

Procedure

General. Once the study began, two sessions were conducted per school day. The majority of sessions were conducted during the first two natural environment teaching (NET) periods of the morning. These sessions were 15 minutes long and took place in the NET centers within large classroom. Three sessions for Gazala took place in a discrete trial instruction (DTI) classroom because she was late. The same types of items were used regardless of where sessions took place. Sessions were conducted either at tables or on the floor, depending on the activity and the preference of the child. An in-vivo preference assessment was conducted prior to each session and items were picked that were consistent with the child's preferences. The procedure for this was the interventionist holding up a variety of items and seeing which the child chose, or by following the child to items he/she walked toward and began playing with. If a participant's behavior indicated he/she was no longer interested in the items being used (e.g., by no longer looking at or reaching for items, or by looking at or reaching for other items), another in-vivo assessment was done and different items were used if necessary.

Baseline. Baseline data were collected prior to the introduction of intervention. During baseline, the interventionist and participant each had an iPad within three inches, with one oriented toward the child and one toward the interventionist. Each iPad had the two available icons ("Look" and "Cool!") The interventionist played with the child, using the preferred items, for long enough to verify engagement. Then the interventionist activated the "Look" button on the iPad and held up a preferred item, while engaging in partner-directed gaze (PDG). If the child held up an item, appropriately activated the "Look" or "Cool!" icons, or engaged in PDG, this was indicated on the data sheet by circling "Look", "Cool!", and/or PDG. During baseline, no prompting or reinforcement were provided. Vocal praise, such as "Good sitting" or "Nice job playing with your toys," was given intermittently for appropriate behavior. Ten trials were conducted during each baseline session, and two sessions were conducted per day.

Intervention Phase 1. During the first intervention phase, the interventionist continued to model all behaviors in the chain (activating "Look," holding up an item, engaging in PDG, and activating "Cool!" if relevant), but only targeted the skill of holding up the toy. Ten teaching trials were run each session; two sessions were conducted each school day. Mastery criteria were met when the participant responded independently and accurately in 80% or more of trials over three consecutive sessions.

Intervention Phase 2. During the second intervention phase, the interventionist modeled all behaviors in the chain, but targeted holding up the item and activating the "Look" icon. The order of these two steps did not matter, as long as one was initiated within five seconds, and both were completed with no more than a five-second latency between them. Ten teaching trials were run each session; two sessions were conducted each school day. Mastery criteria were met when

the participant responded independently and accurately in 80% or more of trials over three consecutive sessions.

Intervention Phase 3. During the third intervention phase, the interventionist modeled all behaviors in the chain, and targeted holding up the item, activating the "Look" icon, and engaging in PDG. Ten teaching trials were run each session; two sessions were conducted each school day. Mastery criteria were met when the participant responded independently and accurately in 80% or more of trials over three consecutive sessions.

Maintenance. Three maintenance sessions were conducted for participants for whom mastery criteria was reached for Phase 3. Maintenance sessions occurred six, 13, and 15 days after mastery criteria were met, and followed identical procedures to baseline, with no prompting or modeling, and reinforcement provided only for appropriate sitting or other non-study related behavior.

Generalization. Generalization probes were conducted during each phase. During generalization probes, the participants were observed in the free play area of the classroom for ten minutes, to assess whether they engaged in any prelinguistic or linguistic communication with each other or with any adult in the room. Participants had access to their devices during generalization probes (i.e., each participant's device was within three feet of him/her), but no prompting occurred. Data were collected on frequency of initiations of holding up a toy, activating the "Look" button or saying "Look," and engaging in partner-directed gaze with a peer or any adult in the room.

Results

The results for all three participants are found in Figures 3-5. Data were analyzed using visual analysis of immediacy of effect, trend, level, stability, magnitude, and percentage of non-

overlapping data (PND). Baseline data for holding up the item and activating the "Look" icon were stable, with none of the participants engaging in either of those behaviors prior to intervention. Some partner-directed gaze (PDG) was observed in baseline for all three participants but was variable. One participant, Shontae, mastered all phases of the study. Gazala and Diego did not master any phases of the study, though both showed some increases in the prelinguistic behavior of holding up a toy, and in partner-directed gaze (PDG). Shontae's results maintained following the conclusion of intervention. Generalization was not observed for any participant during the generalization probes. However, two of the participants did engage in some of the target behaviors at least once outside the intervention sessions.

Shontae

As depicted in Figure 3 (See Appendix D), Shontae never held up an item or activated the "Look" icon in baseline. Occasionally, he did engage in PDG in baseline (*M*=45%, range: 20-80%). Because this was not the behavior being targeted in Phase 1, Shontae entered intervention after four baseline sessions, despite his PDG being on an increasing trend. The intervention showed an immediate effect for Shontae, and by the third intervention session his data were on an increasing trend. He required just eight sessions to master Phase 1, and had 96% PND between baseline and Phase 1. An immediate effect was also seen in Phase 2, with Shontae meeting mastery criteria in seven sessions, with 100% PND from baseline. Shontae's PDG increased in Phase 1, ultimately meeting mastery criteria even though it was not targeted directly until Phase 3. However, his PDG decreased immediately when the Phase 2 response, activating "Look" on the SGD, was added. He did not reacquire it until it was directly targeted in Phase 3. Though PND on PDG between baseline and Phase 3 was moderate, at 64%, his PND between

Phase 2 (i.e., when his PDG decreased coinciding with the extra response effort of activating the SGD) and Phase 3 was 100%.

Shontae maintained mastery of all three acquired skills across three maintenance probes, which were conducted six, 13, and 15 days after initial mastery. His percentages correct on maintenance probes for all three targeted skills all averaged 93.3% (range: 80%-100%). Though Shontae did not demonstrate any of the targeted behaviors in actual generalization probes, he did demonstrate some of these outside session throughout the rest of the preschool day, as documented by his instructors. Shontae held up an item to show his instructor outside session in Phase 1. In Phase 2, Shontae initiated holding up an item and vocally saying, "Look" during the study procedures, but before the interventionist had modeled the behavior. In Phase 3, Shontae held up an item and vocally said, "Look" outside session a total of four times. Shontae activated the "Cool!" icon three times and said "Cool!" three times vocally, though none were at the appropriate time for commenting on the interventionist holding up an item.

Gazala

As depicted in Figure 4 (See Appendix E), Gazala also never held up an item or activated "Look" during baseline, but she engaged in moderately-high levels (*M*=53%, range: 20-80%) of PDG throughout baseline. Gazala did not master any phase of the study, but did show a slight increasing trend in holding up the item following baseline. Gazala's PND between baseline and Phase 1 was 28%. Gazala's PDG increased during intervention (*M*=75%, range:10-100%), eventually meeting mastery criteria of 80% for three sessions in a row. However, because PDG was never targeted alone (i.e., both other targeted responses were required alongside PDG in Phase 3, which Gazala never entered), she did not technically master the PDG phase. Gazala did not demonstrate any of the target behaviors during generalization probes, but her instructor noted

that she held up an item in a similar way outside session on the last day of intervention. Gazala never activated the "Cool!" icon.

Diego

As depicted in Figure 5 (See Appendix F), Diego never held up an item or activated "Look" during baseline. He did engage in limited PDG throughout baseline (*M*=44%, range: 0-90%). Diego also did not master any phase of the study, but did show a slight increasing trend in holding up the item following baseline. Diego's PND between baseline and Phase 1 was 16%. Like Gazala, Diego's PDG increased during intervention (*M*=77%, range: 10-100%), meeting the mastery criteria of 80% across three sessions. Also like Gazala, he did not technically master the PDG phase, since he never mastered Phase 1 and was never officially in Phase 3. In the last four sessions, Diego was demonstrating the target behavior in Phase 1 independently and accurately on some trials every session, and responded with 100% accuracy during one session. Due to time constraints, the study ended before we could see if this increasing trend would continue. Diego did not demonstrate any of the target behaviors in generalization probes or outside intervention sessions. Diego activated the "Cool!" twice, though none were at the appropriate time for commenting on the interventionist holding up an item.

Discussion

The purpose of the current study was to evaluate the effects of a multi-phase intervention package using prompting, modeling, and social praise on prelinguistic and linguistic partner-directed play communicative behaviors in three preschoolers with ASD who used SGD to communicate. The authors sought to explore whether the treatment package was effective for increasing holding up a toy, saying or activating the word "Look" on the SGD, and the use of

partner-directed gaze; as well as to determine whether any observed effects maintained after intervention ended and generalized to a natural environment setting with peers with ASD.

In baseline, all three preschoolers with ASD and limited speech used partner-directed communication infrequently and inconsistently. In fact, none of the preschoolers used the linguistic form "Look" (or any other linguistic form) to comment to their play partner in baseline. Further, throughout the baseline phase, none of the participants ever held up a toy to their play partner to comment about their play using prelinguistic communication. The three participants did engage in partner-directed gaze during baseline. However, they did so with low frequency and consistently; frequency and consistency were particularly low for Shontae and Diego.

During intervention, all three participants demonstrated at least some increase in their partner-directed communication. Shontae demonstrated large increases in all three target communicative behaviors (both prelinguistic and linguistic), mastering intervention and maintaining increased rates of partner-directed communication after intervention had ended. Results for Gazala and Diego were much less pronounced, with neither participant reaching the criteria to shift from Phase 1 into Phase 2. However, both Gazala and Diego did increase their partner-directed play communication to some extent after the start of intervention. In fact, Diego achieved a 100% accuracy rate of the prelinguistic physical behavior of holding up a toy and "showing" it in one session toward the end of the study. Unfortunately, time constraints required the intervention to end before it could be determined whether he would soon reach mastery criteria.

Both Shontae and Gazala demonstrated some of the target behaviors outside the intervention sessions, in other parts of the school day. Though none of the target behaviors were

observed during generalization probes, graduate students documented the occurrence of several instances of targeted prelinguistic (i.e., holding up a toy) and linguistic (i.e., vocally saying "Look") behavior from Shontae outside the session, and one instance of prelinguistic behavior from Gazala.

Results from this study are consistent with the broad research literature suggesting the effectiveness of AAC intervention in increasing communication for children with ASD (Ganz et al., 2012). More specifically, the results are consistent with previous research indicating AAC intervention can increase linguistic communication during play activities (e.g., Lorah et al., 2019). Results are also consistent with previous research suggesting children can build gaze behavior as prelinguistic communication during play routines as a result of AAC intervention (Holyfield, 2019). In addition to contributing to this existing evidence base, the current study offered evidence that the procedures used could be effective for combining prelinguistic and linguistic programming into a simple intervention package. Additionally, this study provided information on participant characteristics in the domains of social skills, manding repertoire, and motor imitation prior to intervention. The inclusion of these characteristics allows for consideration of whether any of these skills should be considered prerequisites for any of the target behaviors in this study.

When examining participant characteristics, there are several possible reasons the procedures may have been more effective for Shontae than for Diego or Gazala. First, Shontae was the participant with the most SGD experience prior to the study. Shontae used his device independently to request most preferred items/activities in his classroom environment in a field of 25, sometimes using up to four-word sentences. Though the other two participants never got to the phase in which they would be activating the SGD, Shontae's increased language ability

may have decreased the overall response effort for the total behavior chain. Diego and Gazala, the other two participants, were both new to SGD use. Both had demonstrated the ability to select preferred items from a field of four items, but still required some prompting for new items and made frequent discrimination errors when selecting icons.

In addition, Shontae had the most vocal ability at the time of the study. He had a strong echoic repertoire, though his words were not always intelligible to non-familiar listeners. Shontae made vocal approximations with most requests, and frequently vocalized 1-2 word approximations or full words without his SGD. It is hypothesized that because Shontae had a strong history of reinforcement for both vocalizations and SGD use, and because he frequently said "Look" along with activating the SGD, there could be a relationship between his spoken language and SGD communication.

Further, Shontae had a generalized fine and gross motor imitation repertoire, unlike both of the other two participants. This may have played a role in Shontae engaging in some of the target responses as motor imitation. Diego and Gazala had only acquired a few fine and gross motor actions as imitation in their discrete trial instruction (DTI) programs at the time of the study, so may have been unable to imitate the behaviors being modeled. The relationship between language, whether vocal or with the SGD, is worthy of consideration. It has been suggested that motor imitation may function as a predictor of future vocabulary development in children with ASD (McDuffie, Yoder, & Stone, 2005).

Finally, throughout the study Shontae seemed to show a higher preference for social praise than the other two participants. He frequently smiled and laughed when the interventionists provided social praise. Therefore, the intervention may have been more effective for him if this intervention component was more reinforcing to him.

Interestingly, Gazala and Diego increased their PDG during play in the study without ever reaching this specific phase of the intervention. One explanation for this observation is that the value of social praise as reinforcement may have increased as the study went on, as it was being paired with tangible reinforcement (i.e., access to preferred toys). This could have increased the value of playing alongside another person more generally as a result of the intervention, and therefore led to more visual attending to the other person. Another explanation is that the participants were demonstrating the PDG as a standalone communicative behavior that they learned from the interventionists looking toward them while modeling and prompting the target behavior from Phase 1 (i.e., physical "showing" of a toy). While not directly targeted, Gazala and Diego may have acquired use of this prelinguistic communication because it is the least demanding behavior of the three targeted from a motor standpoint.

Implications for Practice

Given its small scope and the variability of results observed, the implications for clinical practice from the current study are limited. However, this study finds further evidence that social communication to play partners is limited from preschoolers with ASD who do not have functional speech. Given the importance of play to development in early childhood (Samuelsson & Johansson, 2006; Toub et al., 2018; & Mathieson & Banerjee, 2010), clinicians should prioritize building such communication in intervention. For children like those in the current study who are primarily prelinguistic communicators, clinicians could consider targeting both increased frequency and consistency of existing prelinguistic communicative behaviors as well as the emergence of new prelinguistic and linguistic partner-directed communicative behaviors (Holyfield, 2019).

When addressing such targets in intervention, clinicians could consider using the approach evaluated in the current study with preschoolers with ASD who use SGD. While this study is preliminary, the intervention evaluated used intervention components such as the use of modeling (Steinbrenner et al., 2020), physical prompting (Steinbrenner et al., 2020), and high-tech AAC (Ganz et al., 2012), which all have empirical support for use with children with ASD. Still, clinicians should carefully monitor progress over time to determine if the intervention is effective for a given preschooler with ASD, making adjustments accordingly. While ongoing data collection is critical to effective intervention, it is particularly important for it to happen early and often when implementing interventions with which only emerging empirical evidence is available.

Limitations and Future Research Directions

The external validity of the current study was limited by the variability of results observed, and the lack of experimental effect across all three participants. The fact that each participant was also participating in a multiple baseline across behaviors somewhat mitigates that limitation, as the procedures did show three replications of experimental effect for Shontae. However, more research is needed to determine whether these procedures would be effective for other participants with learning profiles similar to those in this study. Particularly, future research should continue to consider whether the size of the manding, motor imitation, and social skills repertoires impact acquisition of the behaviors targeted in this study.

Another limitation of the current study was the limited time available to complete it. Because social communication is a central deficit for individuals with ASD, developing new prelinguistic and linguistic communicative behaviors could be expected to take some time (APA, 2013). Due to time constraints, intervention for Diego was started before a treatment effect was

seen for Gazala. Also, intervention had to end before either Diego or Gazala mastered the target behaviors. Additionally, the fact that an adult investigator served as the play and communication partner throughout the study was a limitation. It was a logical initial step in evaluating an intervention in which communication during play is modeled by a more expert communicator. However, the ultimate goal of increasing partner-directed communication during play in preschoolers with ASD is so that they may more fully participate in play with other preschoolers. While skill-building is important, the meaningfulness of progress in AAC intervention is ultimately judged by the impact it has on participation in daily life (Light & McNaughton, 2015).

Conclusion

For preschoolers, play is a critical context for learning, building language, social communication, and forming peer relationships (Samuelsson & Johansson, 2006; Toub et al., 2018; Mathieson & Banerjee, 2010). For preschoolers with ASD, play may be a particularly critical context given their risks for limitations in development relative to those areas, such as social communication (APA, 2013). Yet, without intervention, participation in such contexts may be low for many preschoolers with ASD who do not have functional speech. While more research is needed to determine best practices for supporting preschoolers with ASD in building partner-directed communication during play, the current study provides initial evidence that AAC intervention can increase prelinguistic and linguistic social communication for at least some preschoolers with ASD during play. Future research should continue to explore interventions until all children have the opportunity to participate fully in social play.

Chapter Four

Strategies for Increasing Prelinguistic and Linguistic Communication in SGD-Users with ASD

Abstract

The manuscript is directed toward practitioners working with young children with autism spectrum disorder (ASD) who use speech-generating devices (SGD), and provides research-based guidelines for increasing opportunities for both prelinguistic and linguistic communication in that population. Using the literature reviewed in the first article, as well as the research reviewed and conducted related to the second article, this final article provides research-based strategies for increasing a variety of communicative behaviors, including prelinguistic (i.e., joint attention, gestures, and eye contact) and linguistic (i.e., SGD use as well as vocalizations alongside SGD use), in SGD-users with ASD.

Keywords: augmentative and alternative communication; autism spectrum disorder; speech-generating device; prelinguistic communication; linguistic communication; vocalizations

Introduction

Individuals with autism spectrum disorder (ASD) who do not have functional vocal speech may be candidates for augmentative and alternative communication (AAC) systems (Ganz et al., 2012). One type of AAC with a wide body of evidence supporting its use is the speech-generating device (SGD; Steinbrenner et al., 2020). SGDs allow individuals to select a word, picture, or message on a screen, which is then read in a digital or synthetic voice. There is support in the literature indicating SGD-users with ASD can be taught to engage in a range of prelinguistic (i.e., not involving symbols or words) and linguistic (i.e., involving symbols or words) behaviors. This research should guide practitioners when selecting targets and teaching methods for these individuals. This article will provide suggestions taken from the literature that have been effective for increasing both prelinguistic and linguistic communication in SGD-users with ASD, and consolidate them into a guide for practitioners to consider when selecting targets and teaching procedures.

Appropriate SGD Candidates

Any individual who does not communicate functionally using spoken language should be considered a candidate for AAC (Holyfield, 2019). Three common AAC modalities for individuals with ASD who possess the necessary motor skills (i.e., who do not also have a comorbid diagnosis that affects their ability to use their hands) are SGD, picture exchange communication system (PECS), and manual sign. When choosing between these three modalities, several factors should be considered. Among them are the evidence base for each, the individual's preference, and his/her motor skills (van der Meer et al., 2012; McLay et al., 2015; McLay et al., 2017). This article will look specifically at factors related to those for whom SGD has been determined to be the most appropriate AAC system to use.

Prelinguistic Communication with SGD

Prelinguistic (also called presymbolic or nonsymbolic) communication refers to that which does not involve symbols, such as words, pictures, or manual signs with assigned meanings (Ogletree & Pierce, 2010). Some prelinguistic behaviors include eye gaze, gestures, facial expressions, body movements, vocalizations that are not words or word approximations, and joint attention (Ogletree & Pierce, 2010). Joint attention refers to the sharing of attention between two or more people, based around an object or activity (Mundy, 1995). For example, when a parent spins a top for a child, and the child looks back-and-forth from the parent to the top, joint attention has been demonstrated. In typically-developing children, joint attention generally forms between 9-12 months of age (Carpenter et al., 1998). Researchers have found that the ability to engage in joint attention is a predictor of social competency in adults with ASD (Gillespie-Lynch et al., 2012). For these reasons, it is important to identify effective interventions for teaching joint attention and other prelinguistic behaviors to young children with ASD.

Individuals who engage in linguistic communication (i.e., communication that does involve words, pictures, manual signs, or other symbols) continue to use prelinguistic behaviors, because they are still beneficial for enhancing the speaker's ability to convey a message. For instance, when someone says or otherwise communicates the phrase, "Go get the cup," he/she may also point to which cup is wanted. Gestures such as shrugging shoulders or raising eyebrows, or facial expressions such as smiling or cringing, can communicate a message as clearly as, if not sometimes more clearly than, spoken words.

Choosing prelinguistic communication targets. When choosing any type of teaching target for a learner with ASD, whether prelinguistic or linguistic, practitioners should give

consideration to what types of communication will most enhance the life of the individual being considered, as well as what types will be useful for any child regardless of environment (Kaiser & Trent, 2007, p. 224). Practitioners are advised to think of all the environments in which the individual will need to communicate.

Table 3 (see Appendix H) summarizes research-based guidelines for choosing prelinguistic communication targets for individuals with ASD who use SGD. When choosing which prelinguistic communication skills to target for SGD-users with ASD, consider the environments in which the child will find himself/herself (Prior & Roberts, 2012). For instance, for a child who has many siblings and/or is often in a noisy setting, it may be especially helpful to teach the behavior of walking to the intended listener and making physical contact (i.e., touching the arm or tapping on the shoulder) before activating the SGD. In addition to considering the individual needs of the child, there are some prelinguistic behaviors that will be beneficial to any child who acquires them. For instance, the development of joint attention can predict later communication ability (Olswang et al., 2014); and eye gaze, in addition to being a vital component of joint attention, can also be a key indicator that a child is attending to a given stimulus (Holyfield, 2019). Pointing is another important beneficial prelinguistic behavior. It not only helps those observing know what object a child is indicating (which, in turn, makes reinforcement more likely to occur), but it has been linked to better language outcomes (Lüke et al., 2017). Research has shown that prelinguistic behaviors that are responded to as if they are intentional (e.g., responding to eye gaze as if it was intended as communication) can be shaped into behaviors that are used intentionally (Holyfield, 2019). For this reason, practitioners should consider targets that can be shaped into intentional communication, even if there is no indication the child is using them to convey a specific message prior to intervention.

Prelinguistic communication teaching strategies. Table 4 (see Appendix I) summarizes some of the research-based teaching strategies practitioners may consider when targeting prelinguistic behavior alongside SGD use. Schertz et al. (2013) reported that parents used excited facial expressions when their children looked at them more than at toys, used gestures to encourage eye gaze in a given direction (i.e., to a parent's face or to a toy), and provided social praise for eye contact. Holyfield (2019) discussed using preferred activities, salient sensory behaviors (SSB; defined as behaviors involving sensory stimuli, which are expected in the context of the activity), and responsivity to gaze behaviors (i.e., reacting to eye gaze as if it was intended as communication). Miller, Holyfield, and Lorah (2020) suggested the use of modeling, constant time delay, physical and positional prompting, and social praise for increasing the use of the gesture of "showing" a toy to another individual and directing eye gaze toward them after pressing the icon for "Look" on their SGD. Lerna et al. (2014) found that children who had PECS training engaged in more joint attention than their peers who had not had similar training. Though this result has not been replicated with SGD-users, one hypothesis for increased joint attention in PECS users could be that looking from a desired item to the PECS book, to the person with whom the exchange is being made, could lead to reinforcement of the ability to quickly shift eye gaze from one item to another item or person. Therefore, it is reasonable to hypothesize that the similar shift in attention needed in order to shift eye gaze from the desired item to the SGD could assist in the development of joint attention, especially if the user is taught to look at the person he/she is directing his/her SGD mand toward. The use of a constant time delay, during which the practitioner waits for eye contact before providing reinforcement, could be a useful strategy to encourage this ability to shift attention quickly.

Linguistic Communication with SGD

There is a growing body of evidence of interventions that support the linguistic development of SGD-users with ASD. Most research related to teaching verbal operants using SGDs has involved multiply-controlled mands with some studies assessing intraverbals and tact-intraverbals (Tincani et al., 2020). Mands are by far the most common verbal operant evaluated, and a variety of types of mands have been studied, including mands for actions (Carnett et al., 2019), multi-step mands (Alzrayer et al., 2017), mands directed toward peers (Lorah et al., 2019), and mands for information (Shillingsburg et al., 2019). Table 5 (see Appendix J) provides a summary of the most commonly-targeted verbal operants within SGD research.

Choosing linguistic communication targets. Manding was the primary operant targeted for instruction in the majority of reviewed studies. It is important for SGD-users to be able to communicate their wants and needs, just as it is for individuals who communicate using spoken words. But communication is about more than just expressing needs. The more types of verbal behavior targeted for instruction using SGD, the more children with ASD can engage in their environment and the world around them. For this reason, a variety of verbal operants should be targeted (Lorah, Tincani & Parnell, 2018; Ganz, 2015)).

When choosing linguistic targets, practitioners should be mindful of what environments individuals participate in regularly, and make sure they are taught to use types of communication relevant to all areas of life (Ganz, 2015). SGDs allow for multiple folders corresponding to different environments or activities (i.e., home, school, playground, circle time). When picking individual targets, practitioners should remember to target a variety of verbal operants (Lorah, Tincani, & Parnell, 2018; Ganz, 2015). Table 6 (See Appendix K) offers suggestions for

appropriate targets for three common preschool or elementary school activities, across three of the most commonly-targeted verbal operants.

In addition to mands, tacts, and intraverbals, some SGD-users may be candidates for targeting autoclitics (Skinner, 1986). Autoclitics are a type of verbal behavior that add emphasis, precision, or clarity to other verbal behavior (Moore, 2008; Skinner, 1986). Examples of autoclitics include phrases such as "I want", "more", and "please." There is support in the literature for teaching the carrier phrases "I see" and "I have" to young children with ASD who use SGD (Lorah, Parnell, & Speight, 2014), though more research is needed in this area.

Linguistic communication teaching strategies. Many evidence-based practices (EBP) for teaching individuals with ASD have been identified (Steinbrenner et al., 2020). Augmentative and alternative communication (AAC) is, itself, considered an EBP, although instruction on how to use the AAC system (whether SGD or otherwise) will also include many other EBPs. Table 7 (See Appendix L) summarizes strategies that have been seen consistently in the literature related to teaching linguistic targets to individuals with ASD who use SGD to communicate. Lorah et al. (2019) used a constant time delay (O'Neill, 2018), physical prompting, and the interrupted chain procedure (Shafer, 1994) to teach three preschoolers with ASD to mand to neurotypical peers for items needed to continue a task (i.e., puzzle). Kagohara et al. (2012) evaluated the use of a constant time delay, least-to-most prompting, and differential reinforcement to teach two teenagers with ASD to tact pictures using Proloquo2Go™. Lorah and Parnell (2017) evaluated the use of a constant time delay and physical prompting to teach tacting with two autoclitic carrier phrases ("I have" and "I see") to three preschoolers with ASD who used Proloquo2Go, during a circle time routine. Lorah et al. (2015) used a five-second time delay, full physical prompts, and social praise on the intraverbal responding of two participants

with ASD who used Proloquo2Go. These studies indicate that a range of verbal operants can be taught to children with ASD who use SGD to communicate and provide a strong evidence base for practitioners who are deciding what teaching strategies for teaching similar targets. Figure 6 (See Appendix L) summarizes many typically-used strategies used to evoke mands in a flow chart.

Strategies for increasing vocalizations. The preceding recommendations for increasing linguistic communication in young children with ASD have focused on SGD use without regard to vocalizations. But a handful of studies identify procedures that may increase vocalizations alongside SGD use in some individuals (Gevarter et al., 2016; Bishop et al., 2020; Gevarter & Horan, 2019). Other recommendations have been found in the pre-SGD AAC literature (Carbone et al., 2010; Tincani, 2004), and may hold some relevance. One procedure for attempting to evoke vocalizations for individuals who already use SGD to mand, formed by consolidating the available research but not explicitly following the full procedures of any, is found in Figure 7 (See Appendix M).

Conclusion

There is a need for continued research into best practices for including prelinguistic and linguistic skills into instruction for individuals with autism spectrum disorder (ASD) who use, or who are candidates for, speech-generating devices (SGD). This article provided a guide for choosing both prelinguistic and linguistic targets for SGD-users and implementing them using evidence-based practices (EBP). As research continues in this area, and practitioners become more familiar with the breadth of instructional methods available, it is hoped that young children with ASD will be provided opportunities to acquire a wider range of prelinguistic and linguistic

behaviors, as are available to their neurotypical peers or peers with ASD who communicate vocally.

Chapter 5

Conclusion

The preceding three manuscripts provided an overview of research related to systematic instruction for young children with autism spectrum disorder (ASD) who are candidates for augmentative and alternative communication (AAC) systems, with a special emphasis on speech-generating devices (SGD). The first manuscript (Chapter 2) offered an introduction to the use of AAC for individuals with ASD, with a focus on current trends in SGD research related to increasing vocalizations. The second manuscript (Chapter 3) reported a study conducted in the University of Arkansas autism program, which evaluated a procedure for teaching the use of prelinguistic and linguistic communicative play behaviors to preschoolers with ASD who use SGD. Finally, the third manuscript (Chapter 4) consolidated the research on prelinguistic and both vocal and linguistic communication into a practitioner's guide, with the aim of providing research-based guidelines for choosing targets and teaching procedures to those who work with children with ASD who use SGD.

There is a need for continued research into best practices for teaching children with ASD to be effective communicators using SGD (Ganz, 2015; Tincani et al., 2020). The areas of need include identifying strategies for incorporating SGD use into classroom environments, further evaluation of interventions for teaching a variety of verbal operants, and more focus on how practitioners can encourage the development of vocalizations alongside SGD use.

If children with ASD are to be able to participate fully with their peers in mainstream, inclusion, and self-contained classrooms, teachers must be able to effectively and efficiently teach and assist students who use SGD. More research into the most efficient and effective teaching procedures will benefit those teaching in environments that do not allow for one-on-one

instruction. The third manuscript (Chapter 4) may provide some guidance for how SGD programming can be incorporated into a variety of preschool or early elementary programming. This is an area with much room for exploration in future research.

As stated previously, most SGD research has been related to mand training (Tincani et al., 2020). Though there are a handful of studies (Lorah et al., 2015; Lorah & Parnell, 2017; Kagohara et al., 2012) evaluating strategies for teaching other verbal operants, single subject research requires multiple replications in order to achieve external validity. Children with ASD who communicate vocally are taught a range of verbal behavior, and it should be no different for those who use SGD. Future research should include targets beyond manding, such as tacting, intraverbals, and the use of autoclitic behavior.

Finally, there is a need for more studies evaluating the role of SGD in increasing vocalizations in those with ASD. The few studies that have evaluated procedures for directly targeting speech (Gevarter et al., 2016; Bishop et al., 2020; Gevarter & Horan, 2019) have shown promising results, but more replication and expansion are needed. Additionally, more research is necessary for outlining what prerequisite skills (i.e., oral motor imitation, echoic ability) are most important in the development of vocalizations alongside SGD use.

In conclusion, the preceding manuscripts are provided to outline both the availability of effective interventions for those with ASD using AAC, specifically SGD, as well as to show areas of need and to offer some preliminary strategies for meeting those needs, based on existing evidence-based practices (EBP; Steinbrenner et al., 2020). There is still much to be investigated related to increasing all types of communication for individuals with ASD who use SGD. It is hoped that by providing this overview and expansion on the existing literature, researchers and

practitioners will grow in their comfort with SGD-related interventions and will continue to strive for making sure all children with ASD have a way to communicate.

References

Albert, K., Carbone, V. J., Murray, D. D., Hagerty, M., & Sweeney-Kerwin, E. J. (2012). Increasing the mand repertoire of children with autism through the use of an interrupted chain procedures. *Behavior Analysts in Practice, 5*(2), 65-76.

Alzrayer, N. M., Banda, D. R., & Koul, R. (2017). Teaching children with autism spectrum disorder and other developmental disabilities to perform multistep requesting using an iPad. *Augmentative and Alternative Communication, 33*(2), 65-76.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Bal, V. H., Kim, S-H., Cheong, D., & Lord, C. (2015). Daily living skills in individuals with autism spectrum disorder from 2 to 21 years of age. *Autism, 19*(7), 774-784.

Bishop, S. K., Moore, J. M., Dart, E. H., Radley, K., Brewer, R., Barker, L-K., …Toche, C. (2020). Further investigation of increasing vocalizations of children with autism with a speech-generating device. *Journal of Applied Behavior Analysis, 53*(1), 475-483.

Carbone, V. J., Sweeney-Kerwin, E. J., Attanasio, V., & Kasper, T. (2010). Increasing the vocal responses of children with autism and developmental disabilities using manual sign mand training and prompt delay. *Journal of Applied Behavior Analysis, 43,* 705-709.

Carnett, A., Bravo, A., & Waddington, H. (2019). Teaching mands for actions to children with autism spectrum disorder using systematic instruction, behavior chain interruption, and a speech-generating device. *International Journal of Developmental Disabilities, 65*(2), 98-107.

Carnett, A., Raulston, T.J. & Charpentier, J. (2019). The application of Skinner's analysis of verbal behavior for teaching communication skills to persons with developmental disabilities. *Current Developmental Disorders Reports, 6,* 131–137.

Carr, E. G. (1994). Emerging themes in the functional analysis of problem behavior. *Journal of Applied Behavior Analysis, 27,* 393-399.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*(4, Serial No. 255), 1–142.

Carter, M., & Grunsell, J. (2001). The behavior chain interruption strategy: A review of research and discussion of future directions. *Research and Practice for Persons with Severe Disabilities, 26*(1), 37–49.

Chang, Y-C., Shih, W., Landa, R., Kaiser, A., & Kasari, C. (2018). Symbolic play in school-aged minimally verbal children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 48,* 1436-1445.

Chazin, K. T. & Ledford, J. R. (2016). Paired stimulus preference assessment. In *Evidence-based instructional practices for young children with autism and other disabilities.* Retrieved from http://ebip.vkcsites.org/paired-stimulus

Centers for Disease Control and Prevention. (2019, September 3). Autism spectrum disorder (ASD): Data and statistics. Retrieved September 29, 2019, from https://www.cdc.gov/ncbddd/autism/data.html

Coon, J. T., & Miguel, C. F. (2012). The role of increased exposure to transfer of stimulus control procedures on the acquisition of intraverbal behavior. *Journal of Applied Behavior Analysis, 45*, 657-666.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2020). *Applied Behavior Analysis, 3rd Edition.* New York, NY: Pearson.

Dawson, G., Jones, E. J., Merkle, K., Venema, K., Lowy, R., Faja, S., . . . Webb, S. J. (2012). Early behavioral intervention is associated with normalized brain activity in young children with autism. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*(11), 1150-1159. doi:10.1016/j.jaac.2012.08.018

Dawson, G., Rogers, S., Munson, J., Smith, M., Winter, J., Greenson, J.,…Varley, J. (2010). Randomized, controlled trial of an intervention for toddlers with autism: The Early Start Denver Model. *Pediatrics, 125*(1), 17-23.

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation for assessing reinforcer preferences. *Journal of Applied Behavior Analysis, 29*(4), 519-532.

Endicott, K., & Higbee, T. S. (2007). Contriving motivating operations to evoke mands for information in preschoolers with autism. *Research in Autism Spectrum Disorders, 1*(3), 210-217.

Esch, B. E. (2008). Early echoic skills assessment. In M. L. Sundberg (Ed.), *Verbal behavior milestones assessment and placement program: The VB-MAPP* (p. 24). Concord, CA: AVB Press.

Fleury, V. P., Thompson, J. L., & Wong, C. (2014). Learning how to be a student: An overview of instructional practices targeting school readiness skills for preschoolers with autism spectrum disorder. *Behavior Modification, 39*(1), 69-97.

Frost, L. A., & Bondy, A. S. (2002). *The picture exchange communication system training manual* (2nd ed.). Newark: Pyramid Educational Products.

Ganz, J. B. (2015). AAC interventions for individuals with autism spectrum disorders: State of the science and future research directions. *Augmentative and Alternative Communication, 31*(3), 203-214, DOI: 10.3109/07434618.2015.1047532

Ganz, J. B., Earles-Vollrath, T. L., Heath, A. K., Parker, R. I., Rispoli, M. J., & Duran, J. B. (2012). A meta-analysis of single case research studies on aided augmentative and alternative communication systems with individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 42*, 60-74. DOI: 10.1007/s10803-011-1212-2

Gerow, S., Davis, T., Radhakrishnan, S., Gregori, E., & Rivera, G. (2018). Functional communication training: The strength of evidence across disabilities. *Exceptional Children, 85*(1), 86–103. https://doi.org/10.1177/0014402918793399

Gevarter, C., & Horan, K. (2019). A behavioral intervention package to increase vocalizations of individuals with autism during speech-generating device intervention. *Journal of Behavioral Education, 28*, 141-167.

Gevarter, C., O'Reilly, M. F., Kuhn, M., Mills, K., Ferguson, R., & Watkins, L. (2016). Increasing the vocalizations of individuals with autism during intervention with a speech-generating device. *Journal of Applied Behavior Analysis, 49*, 17-33.

Gillespie-Lynch, K., Sepeta, L., Wang, Y., Marshall, S., Gomez, L., Sigman, M. (2012). Early childhood predictors of the social competence of adults with autism. *Journal of Autism and Developmental Disorders, 42*(2), 161–174.

Habarad, S. M. C. (2015). The power of the mand: Utilizing the mand repertoire to decrease problem behavior. *Behavioral Development Bulletin, 20*(2), 158-162.

Hall, G. A., & Sundberg, M., L. (1987). Teaching mands by manipulating conditioned establishing operations. *The Analysis of Verbal Behavior, 5,* 41–53.

Hart, S. L., & Banda, D. L. (2010). Picture exchange communication system with individuals with developmental disabilities: A meta-analysis of single subject studies. *Remedial and Special Education, 31*(6), 476–488.

Higbee, T. S., Carr, J. E., & Harrison, C. D. (2000). Further evaluation of the multiple-stimulus preference assessment. *Research in Developmental Disabilities, 21*(1), 61-73.

Holyfield, C. (2019). Preliminary investigation of the effects of a prelinguistic AAC intervention on social gaze behaviors from school-age children with multiple disabilities. *Augmentative and Alternative Communication, 35*(4), 285-298.

Johnson, G., Kohler, K. & Ross. D. (2017). Contributions of Skinner's theory of verbal behaviour to language interventions for children with autism spectrum disorders. *Early Child Development and Care, 187*(3-4), 436-446.

Kagohara, D. M., van der Meer, L., Achmadi, D., Green, V. A., O'Reilly, M. F., Lancioni, G. E., Sutherland, D., Lang, R., Marschik, P. B., & Sigafoos, J. (2012). Teaching picture naming to two adolescents with autism spectrum disorders using systematic instruction and speech-generating devices. *Research in Autism Spectrum Disorders, 6,* 1224-1233.

Kaiser, A.P., Trent, J. A. (2007). Communication intervention for young children with disabilities: Naturalistic approaches to promoting development. In: S. L. Odom, R. H. Horner, M. E. Snell, & J. Blacher (Eds.), *Handbook of developmental disabilities.* New York, NY: Guilford Press.

Keller, F. S., & Schoenfeld, W. N. (1950). *Principles of psychology.* New York: Appleton-Century-Crofts.

Klein, J. L., MacDonald, R. F. P, Vaillancourt, G., Ahearn, W. H., & Dube, W. V. (2009). Teaching discrimination of adult gaze direction to children with autism. *Research in Autism Spectrum Disorder, 3*, 42-49. doi:10.1016/j.rasd.2008.03.006

King, S. A., Lemons, C. J., & Davidson, K. A. (2016). Math interventions for students with autism spectrum disorder: A best-evidence synthesis. *Exceptional Children, 82*(4), 443–462.

Kouri, T. A. (1988). Effects of simultaneous communication in a child-directed treatment approach with preschoolers with severe disabilities. *Augmentative and Alternative Communication, 4*, 222–232.

Krstovska-Guerrero, I., & Jones, E. A. (2016). Social-communication intervention for toddlers with autism spectrum disorder: Eye gaze in the context of requesting and joint attention. *Journal of Developmental and Physical Disabilities, 28,* 289-316.

Lancioni, G., O'Reilly, M., Curvo, A., Singh, N., Sigafoos, J., & Didden, R. (2007). PECS and VOCAs to enable students with developmental disabilities to make requests: An overview of the literature. *Research in Developmental Disabilities, 28*, 468-488.

Leblanc, L. A., Esch, J., Sidener, T. M., & Firth, A. M. (2006). Behavioral language interventions for children with autism: Comparing applied verbal behavior and naturalistic teaching approaches. *The Analysis of Verbal Behavior,22*(1), 49-60. doi:10.1007/bf03393026

Laraway, S., Snycerski, S., Michael, J., & Poling, A. (2003). Motivating operations and some terms to describe them: Some further refinements. *Journal of Applied Behavior Analysis, 36,* 407-414.

Leaf, J. B., Leaf, J. A., Milne, C., Taubman, M., Oppenheim-Leaf, M., Torres, N., . . . Yoder, P. (2017). *Journal of Autism and Developmental Disorders, 47*, 243.

Leaf, J.B., Leaf, R., McEachin, J., Cihon, J. H., & Ferguson, J. L. (2018). Advantages and challenges of a home- and clinic-based model of behavioral intervention for individuals diagnosed with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 48,* 2258–2266. doi:10.1007/s10803-017-3443-3

Ledford, J. R., & Gast, D. L. (2018). *Single case research methodology: Applications in special education and behavioral science, 3rd Edition.* London: Routhledge.

Lerman, D. C., Valentino, A. L., LeBlanc, L. A. (2016) Discrete trial training. In: Lang R., Hancock T., Singh N. (Eds) *Early intervention for young children with autism spectrum disorder. Evidence-based practices in behavioral health.* Switzerland: Springer International Publishing.

Lerna, A., Esposito, D., Conson, M., & Massagli, A. (2014). Long-term effects of PECS on social–communicative skills of children with autism spectrum disorders: a follow-up study. *International Journal of Language & Communication Disorders, 49*(4), 478-485.

Light, J., & McNaughton, D. (2015). Designing AAC research and intervention to improve outcomes for individuals with complex communication needs. *Augmentative and Alternative Communication, 31,* 85-96.

Lorah, E. R., Karnes, A., Miller, J., & Welch-Beardsley, J. (2019). Establishing peer manding in young children with autism using a speech-generating device. *Journal of Developmental and Physical Disabilities, 6,* 791-801.

Lorah, E. R., Karnes, A., Speight, D. R. (2015). The acquisition of intraverbal responding using a speech-generating device in school aged children with autism. *Journal of Developmental and Physical Disabilities, 27,* 557-568.

Lorah, E. R., & Parnell, A. (2017). Acquisition of tacting using a speech-generating device in group learning environments for preschoolers with autism. *Journal of Developmental and Physical Disabilities, 29*(4), 597–609.

Lorah, E. R., Parnell, A., & Speight, D. R. (2014). Acquisition of sentence frame discrimination using the iPad™ as a speech generating device in young children with developmental disabilities. *Research in Autism Spectrum Disorders, 8*(12), 1734–1740. https://doi.org/10.1016/j.rasd.2014.09.004

Lorah, E. R., Tincani, M. & Parnell, A. (2018). Current trends in the use of handheld technology as a speech-generating device for children with autism. *Behavior Analysis: Research and Practice, 18*(3), 317-327.

Lord, C., Rutter, M., DiLavore, P. C., & Risi, S. (1999). *Autism Diagnostic Observation Schedule--Generic (ADOS-G)* [Database record]. APA PsycTests. https://doi.org/10.1037/t17256-000

Lüke, C., Grimminger, A., Rohlfing, K. J., Liszkowski, U., & Ritterfeld, U. (2017). In infants' hands: Identification of preverbal infants at risk for primary language delay. *Child Development, 88*(2), 484-492.

Masi, A., DeMayo, M. M., Glozier, N., & Guastella, A. J. (2017). An overview of autism spectrum disorder, heterogeneity, and treatment options. *Neuroscience Bulletin, 33*(2), 183-193.

Mathieson, K., & Banerjee, R. (2010). Preschool peer play: The beginnings of social competence. *Educational and Child Psychology, 27*(1), 9–20.

Matson, J. L., & Jang, Jing. (2014). Treating aggression in persons with autism spectrum disorders: A review. *Research in Developmental Disabilities, 35*(12), 3386-3391.

McDuffie, A., Yoder, P. & Stone, W. (2005). Linguistic predictors of vocabulary in young children with autism spectrum disorders. *Journal of Speech, Language, and Hearing Research, 48*(5), 1080-1097.

McLay, L., Schäfer, M. C. M., van der Meer, L., Couper, L., McKenzie, E., O'Reilly, M. F., Lancioni, G. E., Marschik, P. B., Sigafoos, J., & Sutherland, D. (2017). Acquisition, preference and follow-up comparison across three AAC modalities taught to two children with autism spectrum disorder. *International Journal of Disability, Development and Education, 64*(2), 117-130.

McLay, L., van der Meer, L., Schäfer, M. C. M., Couper, L., McKenzie, E., O'Reilly, M. F., Lancioni, G. E., Marschik, P. B., Green, V. A., Sigafoos, J., & Sutherland, D. (2015). Comparing acquisition, generalization, maintenance, and preference across three AAC options in four children with autism spectrum disorder. *Journal of Developmental and Physical Disabilities, 27*, 323-339.

Michael J. (2004). *Concepts and principles of behavior analysis, 2nd ed.* Kalamazoo, MI: Association for Behavior Analysis International.

Millar, D. C., Light, J. C., & Schlosser, R. W. (2006). The impact of augmentative and alternative communication intervention on the speech production of individuals with developmental disabilities: A research review. *Journal of Speech, Language, and Hearing Research, 49*, 248-264.

Miller, J., Holyfield, C., & Lorah, E. R. (2020). *Effect of multi-step AAC intervention package on partner-directed communicative behaviors during play in preschoolers with ASD.* Unpublished manuscript, University of Arkansas, Fayetteville, AR.

Mirenda, P. (2003). Toward a functional augmentative and alternative communication for student with autism, manual signs, graphic symbols, and voice output communication aids. *Learning, Speech, and Hearing Services in Schools, 34*, 203–216.

Moore, J. (2008). *Conceptual foundations of radical behaviorism*. Hudson, NY: Sloan.

Morano, S., Ruiz, S., Hwang, J., Wertalik, J. L., Moeller, J., Karal, M. A., & Mulloy, A. (2017). Meta-analysis of single-case treatment effects on self-injurious behavior for individuals with autism and intellectual disabilities. *Autism and Developmental Language Impairments, 2,* 1-26.

Mullen, E. M. (1995). Mullen Scales of Early Learning (AGS ed.). Circle Pines, MN: American Guidance Service.

Mundy, P. (1995). Joint attention and social–emotional approach behavior in children with autism. *Development and Psychopathology, 7,* 63–82.

Ogletree, B., & Pierce, K. (2010). AAC for individuals with severe intellectual disabilities: Ideas for nonsymbolic communicators. *Journal of Developmental and Physical Disabilities, 22*, 273-287. DOI: 10.1007/s10882-009-9177-1

Olsson, C., & Granlund, M. (2003). Presymbolic communication intervention. In R. W. Schlosser, The efficacy of augmentative and alternative communication: Toward evidence-based practice (pp. 299-322). San Diego, CA: Academic Press.

Olswang, L. B., Dowden, P., Feuerstein, J., Greenslade, K., Pinder, G. L., & Fleming, K. (2014). Triadic gaze intervention for young children with physical disabilities. *Journal of Speech, Language, and Hearing Research, 57*(5), 1740–1753.

O'Neill, S. J., McDowell, C., & Leslie, J. C. (2018). A comparison of prompt delays with trial-and-error instruction in conditional discrimination training. *Behavior Analysis in Practice, 11*(4), 370–380.

Peters-Scheffer, N., Didden, R., Korzilius, H., & Sturney, P. (2011). A meta-analytic study on the effectiveness of comprehensive ABA-based early intervention programs for children with Autism Spectrum Disorders. *Research in Autism Spectrum Disorders, 5*(1), 60-69.

Prior, M., & Roberts, J. (2012). Early intervention for children with autism spectrum disorders: Guidelines for good practice. Canberra: FaHCSIA.

Romski, M. & Sevcik, R. (2005). Augmentative communication and early intervention: Myths and realities. *Infants and Young Children, 18*(3), 174-185.

Romski, M.A., Sevcik, R., Hyatt, A., & Cheslock, M. (2002). A continuum of AAC language intervention strategies for beginning communicators. In J. Reichle, D. Beukelman, & J. Light (Eds.), *Exemplary practices for beginning communicators: Implications for AAC* (pp. 1-23). Baltimore, MD: Brookes.

Samuelsson, I. P., & Johansson, E. (2006) Play and learning – inseparable dimensions in preschool practice. *Early Child Development and Care, 176*(1), 47-65.

Schertz, H. H., Odom, S. L., Baggett, K. M., & Sideris, J. H. Effects of joint attention mediated learning for toddlers with autism spectrum disorders: An initial randomized controlled study. *Early Childhood Research Quarterly, 28*, 249-258.

Shafer, E. (1994). A review of interventions to teach a mand repertoire. *The Analysis of Verbal Behavior, 12,* 53-66.

Shillingsburg, M. A., Marya, V., Bartlett, B. L., & Thompson, T. M. (2019). Teaching mands for information using speech generating devices: A replication and extension. *Journal of Applied Behavior Analysis, 52*, 756-771.

Shillingsburg, M. A., & Valentino, A. L. (2011). Teaching a child with autism to mand for information using "how." *The Analysis of Verbal Behavior, 27,* 179-184.

Skinner, B. F. (1953). *Science and human behavior.* New York, NY: Macmillan.

Skinner, B. F. (1957). *Verbal behavior.* Acton, MA: Copley Publishing Group, Inc.

Skinner, B. F. (1986). The evolution of verbal behavior. *Journal of the Experimental Analysis of Behavior, 45,* 115–122.

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). *Vineland Adaptive Behavior Scales* (2nd ed.). Circle Pines, MN: American Guidance Service.

Steinbrenner, J. R., Hume, K., Odom, S. L., Morin, K. L., Nowell, S. W., Tomaszewski, B., Szendrey, S., McIntyre, N. S., Yücesoy-Özkan, S., & Savage, M. N. (2020). *Evidence-based practices for children, youth, and young adults with Autism.* The University of North Carolina at Chapel Hill, Frank Porter Graham Child Development Institute, National Clearinghouse on Autism Evidence and Practice Review Team.

Sundberg, M. L. (2008). *VB-MAPP Verbal behavior milestones assessment and placement program: A language and social skills assessment program for children with autism or other developmental disabilities: guide.* Mark Sundberg.

Sundberg, M. L., & Michael, J. (2001). The benefits of Skinner's analysis of verbal behavior for children with autism. *Behavior Modification, 25*, 698-724.

Taylor, B. A. & Hoch, H. (2008). Teaching children with autism to respond to and initiate bids for joint attention. *Journal of Applied Behavior Analysis, 41,* 377-391. doi:10.1901/jaba.2008.41-377

Thiemann-Bourque, K., Feldmiller, S., Hoffman, L., & Johner, J. (2018). Incorporating a peer-mediated approach into speech-generating device intervention: Effects on communication of preschoolers with autism spectrum disorder. *Journal of Speech, Language, and Hearing Research, 61*(8), 2045-2061.

Tiger, J. H., Hanley, G. P., & Bruzek, J. (2008). Functional communication training: A review and practical guide. *Behavior Analysis in Practice, 1*(1), 16-23.

Tincani, M. (2004). Comparing the Picture Exchange Communication System and sign language training for children with autism. *Focus on Autism and Other Developmental Disabilities, 19*(3), 152-163.

Tincani, M., Crozier, S., & Alazetta, L. (2006). The Picture Exchange Communication System: Effects on manding and speech development for school-aged children with autism. *Education and Training in Developmental Disabilities, 41*(2), 177-184.

Tincani, M., Miller, J., Lorah, E. R., & Nepo, K. (2020). Systematic review of verbal operants in speech generating device research from Skinner's Analysis of Verbal Behavior. *Perspectives on Behavior Science*. https://doi.org/10.1007/s40614-020-00243-1

Toub, T. S., Hassinger-Das, B., Nesbitt, K. T., Ilgaz, H., Weisberg, D. S., Hirsh-Pasek, K., … Dickinson, D. K. (2018). The language of play: Developing preschool vocabulary through play following shared book-reading. *Early Childhood Research Quarterly, 45*, 1-17.

Wodka, E. L., Mathy, P., & Kalb, L. (2013). Predictors of phrase and fluent speech in children with autism and severe language delay. *Pediatrics, 131*, 1128–1134.

van der Meer, L., Didden, R., Sutherland, D., O'Reilly, M. F., Lancioni, G. E., & Sigafoos, J. (2012). Comparing three augmentative and alternative communication modes for children with developmental disabilities. *Journal of Developmental and Physical Disabilities, 24,* 451-468.

Yoder, P. J., & Stone, W. L. (2006). A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *Journal of Speech, Language, and Hearing Research, 49,* 698-711.

Appendices

Appendix A

Table 1
Studies Targeting Vocalizations as a Dependent Variable

Citation	AAC Modality	N
Bishop, S. K., Moore, J. M., Dart, E. H., Radley, K., Brewer, R., Barker, L-K., …Toche, C. (2020). Further investigation of increasing vocalizations of children with autism with a speech-generating device. *Journal of Applied Behavior Analysis, 53*(1), 475-483.	Speech-generating device	3
Carbone, V. J., Sweeney-Kerwin, E. J., Attanasio, V., & Kasper, T. (2010). Increasing the vocal responses of children with autism and developmental disabilities using manual sign mand training and prompt delay. *Journal of Applied Behavior Analysis, 43,* 705-709.	Manual sign	3
Gevarter, C., & Horan, K. (2019). A behavioral intervention package to increase vocalizations of individuals with autism during speech-generating device intervention. *Journal of Behavioral Education, 28*, 141-167.	Speech-generating device	6
Gevarter, C., O'Reilly, M. F., Kuhn, M., Mills, K., Ferguson, R., & Watkins, L. (2016). Increasing the vocalizations of individuals with autism during intervention with a speech-generating device. *Journal of Applied Behavior Analysis, 49*, 17-33.	Speech-generating device	4
Tincani, M. (2004). Comparing the Picture Exchange Communication System and sign language training for children with autism. *Focus on Autism and Other Developmental Disabilities, 19*(3), 152-163.	Picture Exchange Communication System	2
Tincani, M., Crozier, S., & Alazetta, L. (2006). The Picture Exchange Communication System: Effects on manding and speech development for school-aged children with autism. *Education and Training in Developmental Disabilities, 41*(2), 177-184.	Picture Exchange Communication System	1

Note. This table provides the citation, AAC modality, and total number of participants for all studies included in the review.

Appendix B

Table 2
Participant Information

Participant	Diagnosis	Age	SGD Use	VB-MAPP milestones scores		
				Social skills	Mand repertoire	Motor Imitation
Shontae	ASD	5;7	Field of 25; multiple folders	4	10	10
Gazala	ASD	3;11	Field of four; single folder	3.5	3	0.5
Diego	ASD	4;7	Field of four; single folder	2.5	2	1

Note. This table provides demographic and skill repertoire information on all three participants.

Appendix C

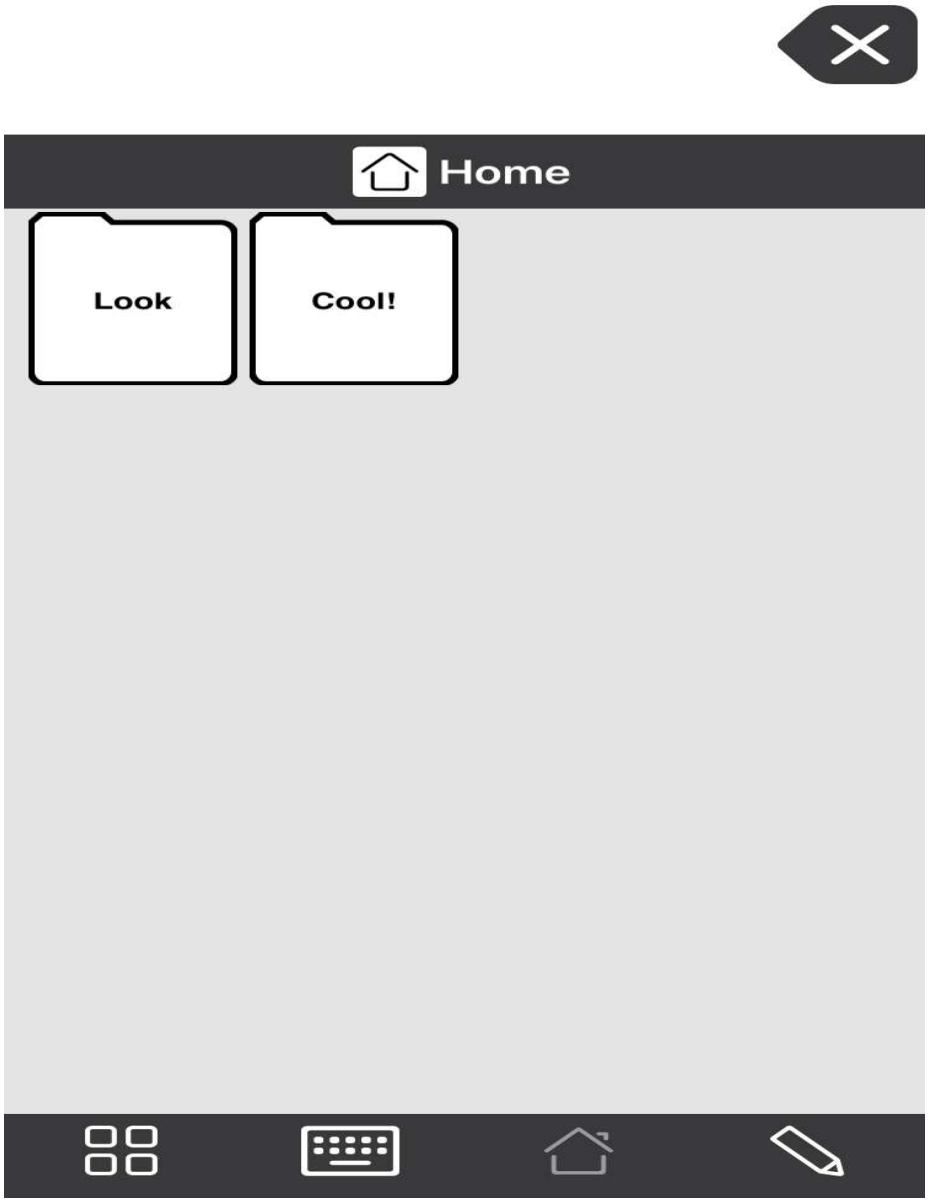

Figure 1
Proloquo2Go™ Screen
Note. This figure is a capture of the screen participants used to activate the "Look" or "Cool!" icons.

Appendix D

Procedural Fidelity:	Did I follow the procedures as described above?	Y N
	Did I provide any prompting or error correction during baseline?	Y N
	Did I follow the prompting procedure during intervention?	Y N
	Did I collect data as described above?	Y N

Figure 2

Procedural Fidelity Checklist

Note. This figure shows the procedural fidelity checklist used by implementers.

Appendix E

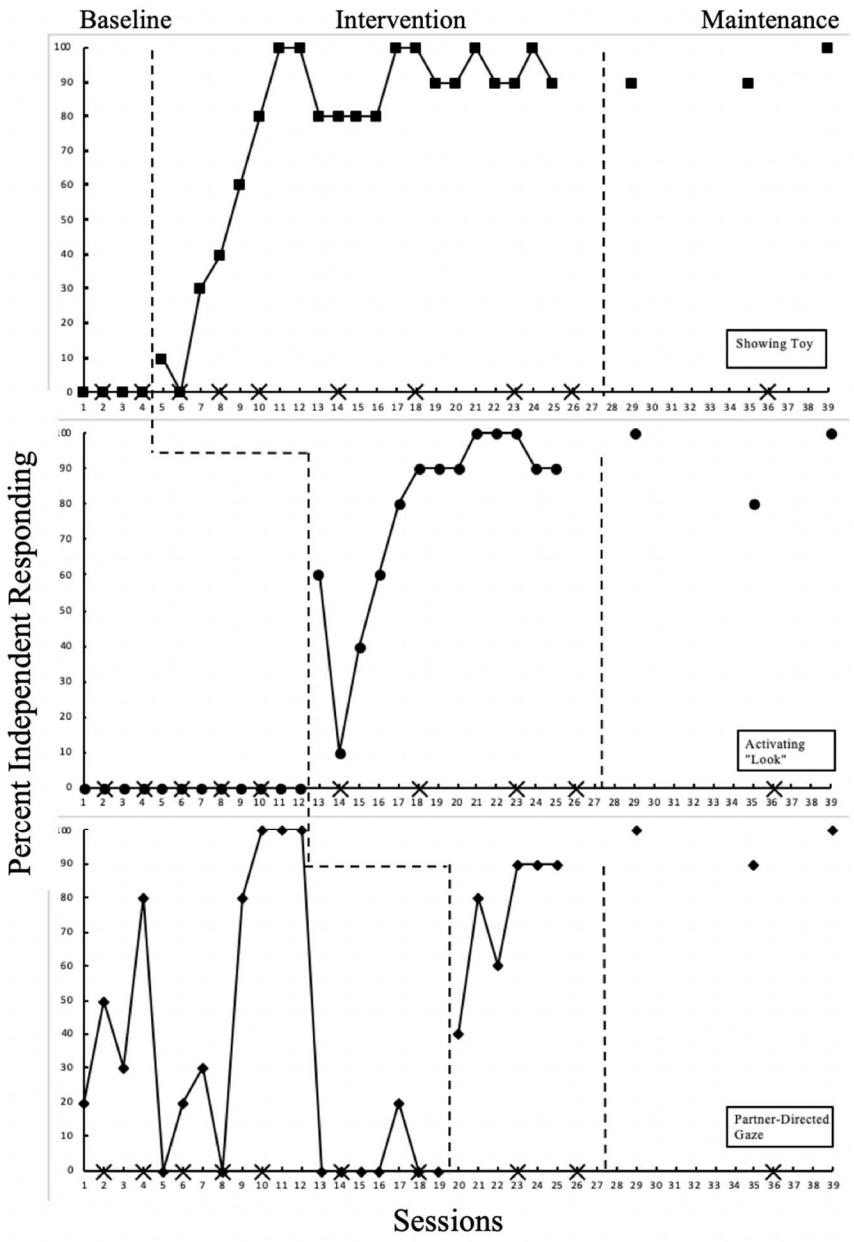

Figure 3
Shontae's Results
Note. This figure depicts the percentage of independent responses across baseline, intervention phases 1-3, and maintenance for Shontae.

Appendix F

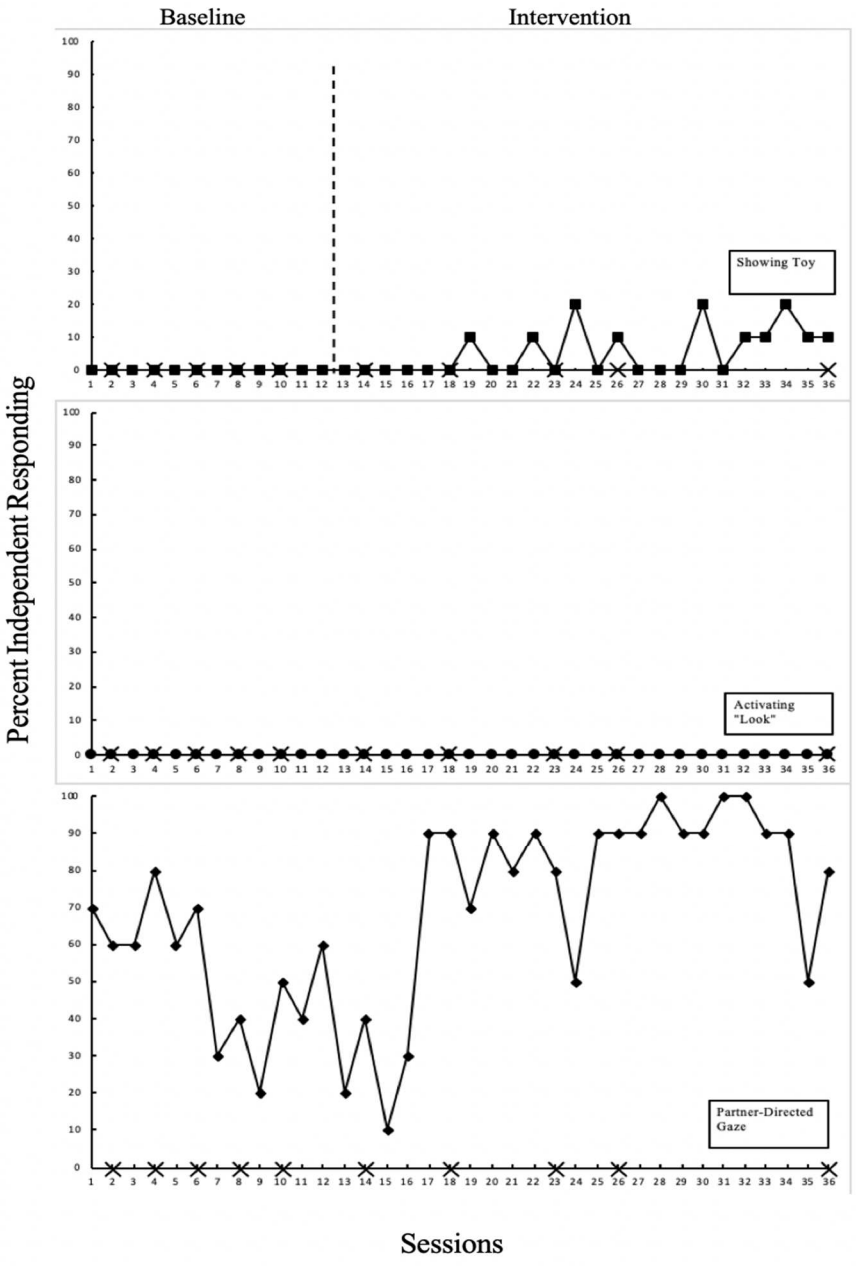

Figure 4
Gazala's Results
Note. This figure depicts the percentage of independent responses across baseline, intervention phases 1-3, and maintenance for Gazala.

Appendix G

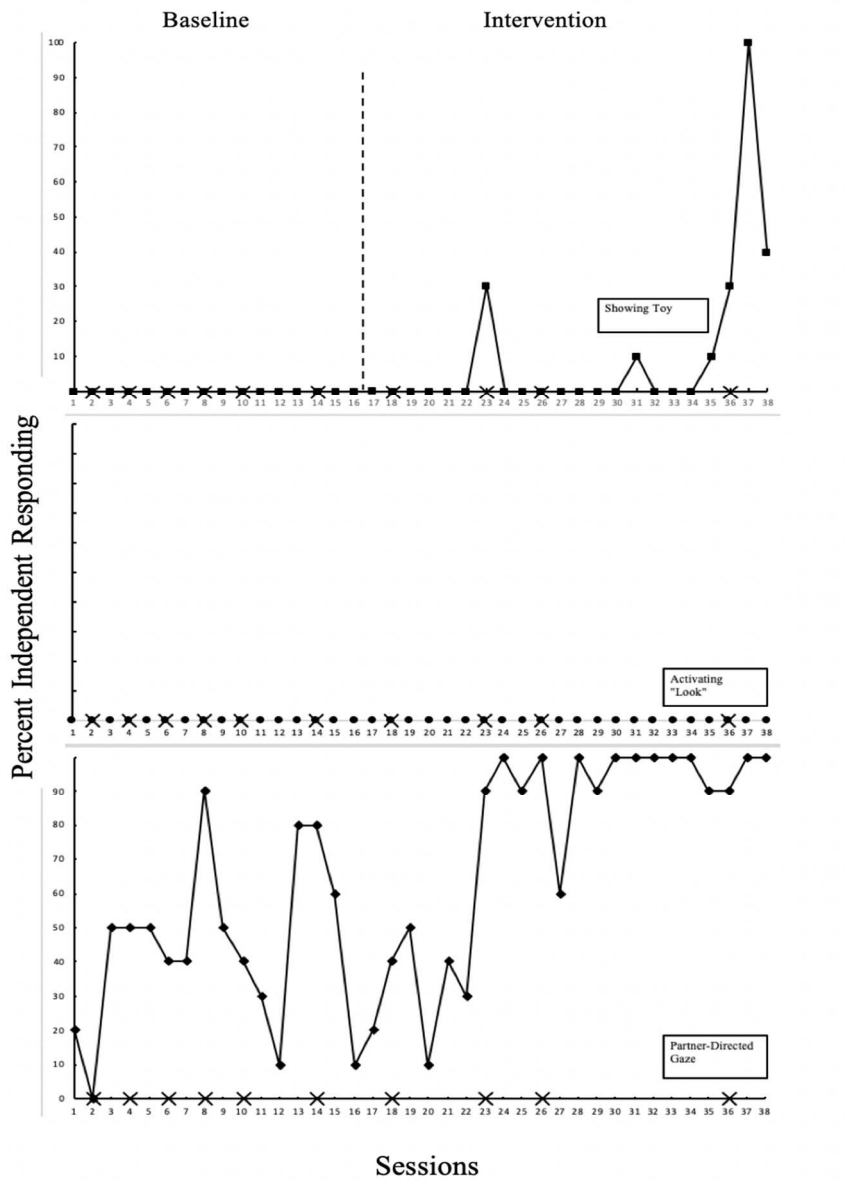

Figure 5
Diego's Results
Note. This figure depicts the percentage of independent responses across baseline, intervention phases 1-3, and maintenance for Diego.

Appendix H

Table 3

Incorporating Prelinguistic Targets into Preschool Routines using SGD

Target	Circle Time	Art	Snack	References
Pointing and other gestures	• pointing to days of the week/numbers on the calendar • pointing to pictures in books • pointing to desired items • playing peek-a-boo • holding up a toy to show peers • holding up a book to show peers • clapping for peers or as part of a song	• pointing to desired items • pointing to parts of the art project • holding up art project to show peers	• pointing to peers at the table • pointing to desired snack items • pointing to make a choice between two snack items being held up • holding up food to show peers	Holyfield, 2019; Schertz et al., 2013; Miller, Holyfield, & Lorah, 2020
Joint attention	• shifting eye gaze from practitioner to peer and back • shifting eye gaze from practitioner to calendar or book and back • playing an instrument along with peers • looking at practitioner or peers when an unexpected noise occurs	• shifting eye gaze from practitioner to art project • following practitioner's point to get a specific material • clapping for peer's art project	• shifting eye gaze from practitioner to food • helping practitioner pass out materials to each peer (joint attention occurs if the child looks from the materials to the peer while passing items)	Schertz et al., 2013; Holyfield, 2019

Note. This table provides suggestions for choosing prelinguistic communication targets for preschoolers with ASD who use SGD.

Appendix I

Table 4
Strategies for Teaching Prelinguistic Behavior

Strategy	Example	References
Conduct frequent preference assessments	Paired stimulus Multiple stimulus without replacement	Chazin & Ledford, 2016; Higbee, Carr, & Harrison, 2000
Limit distractions	Have minimal toys or noise sources	Klein et al., 2009
Use exaggerated sounds and motions to gain attention	Hand motions Facial expressions Sound effects	Holyfield, 2019; Schertz et al., 2013
Respond to eye contact as if it is intentional, even if unknown	Vocal praise Smiling Excited comments Tangible reinforcement	Holyfield, 2019 Schertz et al., 2013
Use an interrupted chain procedure	Interrupt toy play or a familiar routine and wait for eye contact before continuing	Carter & Grunsell, 2001
Use a constant time delay	Withhold wanted items for 3-5 seconds to see if eye contact, gestures, or vocalizations occur	Schertz et al., 2013; Miller, Holyfield, & Lorah, 2020
Model and prompt SGD use in conjunction with gestures	Activate "Look" and hold up a toy; prompt child to do the same	Miller, Holyfield, & Lorah, 2020; Holyfield, 2019; Schertz et al., 2013
Use gestural prompts to direct eye gaze	From practitioner's face back to a toy or vice versa	Holyfield, 2019
Reinforce any independent demonstration of gaze shift from an item to practitioner	Vocal praise Smiling Excited responses Tangible reinforcement	Schertz et al., 2013; Holyfield, 2019
Prompt and reinforce pointing	Model or physically prompt child to point to desired item before providing it	Taylor & Hoch, 2008
Reinforce following a point or eye gaze	Point or look at an item that can be activated remotely; if the child looks, immediately activate; prompt by activating briefly if needed Have a familiar person stand across the room; point or look at them; if the child looks, have them perform funny actions or sounds	Klein et al., 2009; Taylor & Hoch, 2008

Note. This table outlines strategies for teaching prelinguistic communication to preschoolers with ASD who use SGD.

Appendix J

Table 5
Common Verbal Operants taught with SGD

Verbal Operant	S^D	Response	Consequence
Mand (Skinner, 1957)	Motivating operation (Michael, 2004)	Says or otherwise indicates (e.g., with SGD) name of item	Direct reinforcement with item/activity
Tact (Skinner, 1957)	Sensory stimuli (e.g., sees or smells food; hears airplane)	Says or otherwise indicates name of item	Non-specific reinforcement (e.g., verbal praise; acknowledgement)
Intraverbal (Skinner, 1957)	Someone else's verbal behavior (e.g., asking a question or making a comment)	Replies with answer or comment	Non-specific reinforcement (e.g., verbal praise; another verbal stimulus)

Note. This table provides information on commonly verbal operants taught to SGD-users with ASD.

Appendix K

Table 6

Incorporating Linguistic Targets into Preschool Routines using SGD

Target	Circle Time	Art	Snack	References
Mand	• choosing songs • asking for missing items (e.g., numbers for calendar) • asking peers for items • requesting to be all done	• requesting art supplies • requesting a turn with a supply • choosing colors of supplies • requesting help • requesting to be all done	• requesting snack items • asking for missing items (e.g., utensils, napkins) • requesting help • requesting to be all done	Carnett et al., 2019; Lorah et al., 2019
Tact	• labeling items in a book or picture • labeling days of the week on the calendar • identifying peers	• labeling colors • labeling supplies • labeling parts of art project	• labeling food and drink items • identifying peers at table • labeling supplies	Kagohara et al., 2012; Lorah & Parnell, 2017; Lorah, Parnell, & Speight, 2014
Intraverbal	• fill-in-the-blank songs • answering questions about the calendar (e.g., days of the week, weather) • answering questions about books or activities	• answering questions about art (e.g., "What animal is that?") • fill-in-the-blank songs related to art projects	• answering questions about snack (e.g. "Who packed your snack?" "What's your favorite food?" • answering questions for missing items (e.g., "Something's missing. What is it?" "Fork")	Lorah, Karnes, & Speight, 2015

Note. This table provides suggestions for choosing linguistic communication targets for preschoolers with ASD who use SGD.

Appendix L

Table 7
Strategies for Teaching Linguistic Behavior

Strategy	Example	References
Use a constant time delay	Withhold wanted items for 3-5 seconds to see if manding occurs; prompt SGD response and reinforce	O'Neill et al., 2018; Kagohara et al., 2012; Lorah & Parnell, 2017; Lorah, Karnes, & Speight, 2015; Lorah et al., 2019
Use an interrupted chain	Interrupt a preferred activity or task; prompt SGD response and reinforce	Carter & Grunsell, 2001; Lorah et al,. 2019; Albert et al., 2012
Have an item missing	Withhold an item needed for an activity (e.g., provide crayons but no paper; provide Mr. Potato Head but no body parts); prompt the SGD response and reinforce	Lorah et al., 2019; Endicott & Higbee, 2007; Albert et al., 2012)
Withhold information	Contrive or capture motivation for an item that requires the child to ask information (e.g., "Where is it?" "Who has it?"); prompt the SGD response and reinforce	Shillingsburg et al., 2019
Use transfer trials	When a prompt is needed, provide an immediate opportunity for the child to respond independently (e.g., "What is this?" Prompt "apple." "That's right, what is it?" Independent response "apple.")	Coon & Miguel, 2012

Note. This table outlines strategies for teaching linguistic communication to preschoolers with ASD who use SGD.

Appendix M

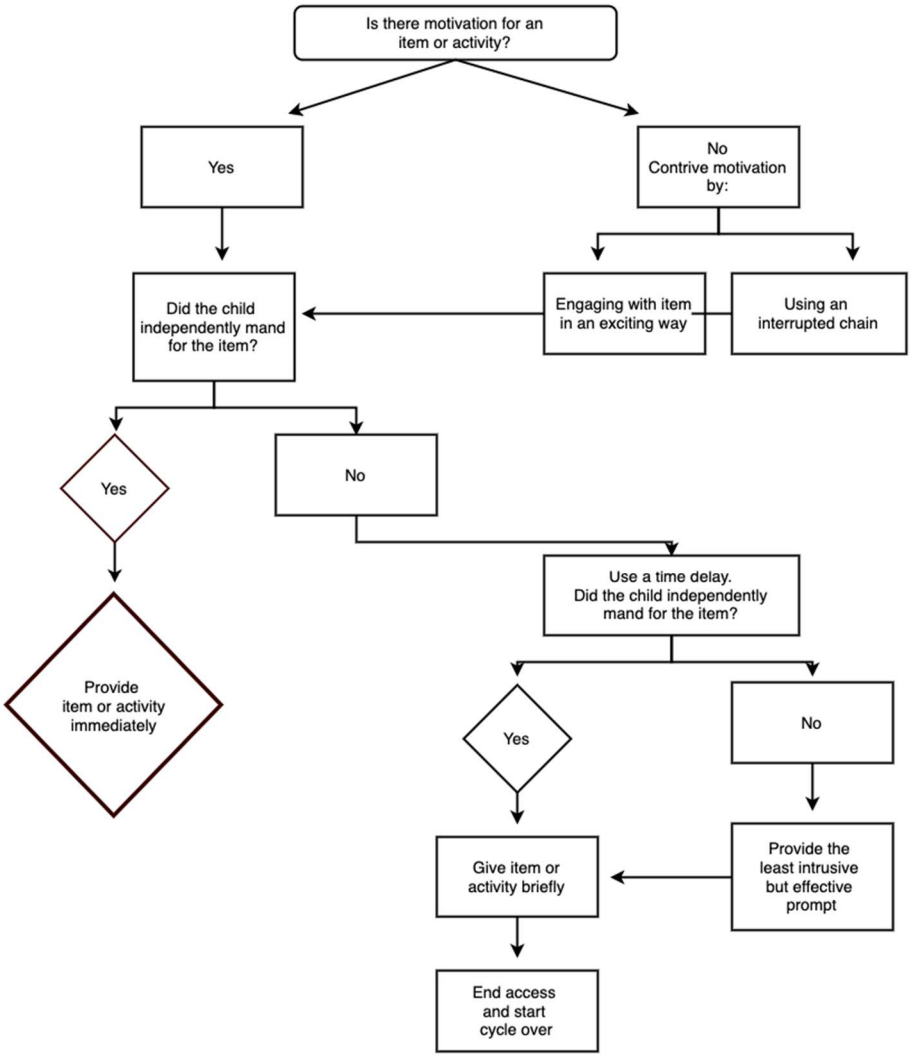

Figure 6
Evoking SGD Mands
Note. This figure provides strategies for evoking mands in SGD-users with ASD.

Appendix N

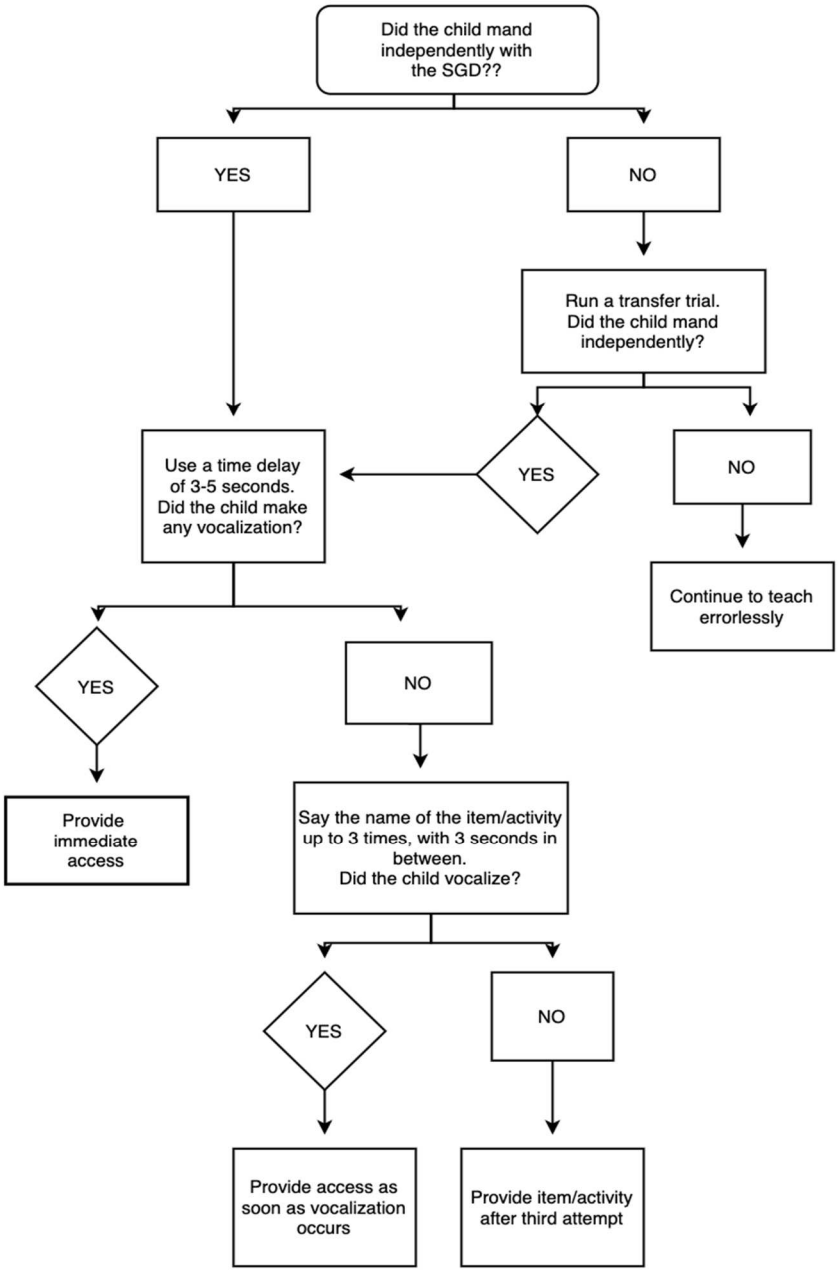

Figure 7
Evoking Vocalizations alongside SGD Mands
Note. This figure provides strategies for evoking vocalizations in SGD-users with ASD.